

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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I declare this is my own work.

# GCSE MATHEMATICS

## Example-Problem Past Paper

# H

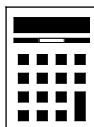
Higher Tier      Paper 3      Calculator

June 2023

### Materials

For this paper you must have:

- a calculator
- mathematical instruments.



### Instructions

- Engage with the fully-worked solutions in full before attempting the shadow questions.
- Explain the fully-worked solutions to yourself, anticipating the next steps in the worked solutions, making links between the problems and the mathematics used to solve them.
- Apply the methods learnt from the fully-worked solutions to the shadow questions, writing down all workings in the spaces provided. Your thought process is important.
- Do all rough work in this book.

### Information

- The marks for questions are shown in brackets.
- You may ask for more answer paper, graph paper and tracing paper.
- You should ask your teacher for help on a question if you don't understand a part of the fully-worked solution. Remember to be specific, understanding why the step was completed, rather than simply getting the correct answer.

### Advice

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

Where a calculator has been used, show clearly what you entered into the calculator.

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]

$y = mx + c$   
 ↑ gradient      ↑ y-intercept  
 Answer ( 0 , 7 )

- 2 Write down a fraction equivalent to 1.875

[1 mark]

$$\frac{1875}{1000}$$

Answer  $\frac{1875}{1000}$

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

[2 marks]

$$\begin{array}{rcl} & -3x & -3x \\ 5x + 11 & = & 3x + 19 \\ -3x & & -3x \\ \hline 2x + 11 & = & 19 \\ -11 & & -11 \\ \hline \end{array}$$

$$\begin{array}{rcl} 2x & = & 8 \\ \div 2 & & \div 2 \\ \hline \end{array}$$

$$x = 4$$

$x =$  4

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

Do not write  
outside the  
box

- 1** The line with equation  $y = 6x - 3$  intersects the  $y$ -axis at A.  
Complete the coordinates of A.

[1 mark]

Answer ( 0 , \_\_\_\_\_ )

- 2** Write down a fraction equivalent to 2.925

[1 mark]

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Answer \_\_\_\_\_

- 3** Solve  $10x - 17 = 4x + 13$

[2 marks]

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$x =$  \_\_\_\_\_

Turn over ►

Shadow paper based on June 2023 question paper

8300/3H

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]

$$1 \text{ cm represents } 5000 \text{ cm} = 50 \text{ m}$$

$\begin{array}{l} \times 50 \swarrow \\ 1 \text{ m} \mid 100 \text{ cm} \\ \hline 50 \text{ m} \mid 5000 \text{ cm} \end{array}$	$\begin{array}{l} \times 4.5 \swarrow \\ 1 \text{ cm} \mid 50 \text{ m} \\ \hline 4.5 \text{ cm} \mid 225 \text{ m} \end{array}$
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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]

$$1\,000\,000 \times 0.96^5 = 815,372.6976$$

Answer 815,373

4 A map has a scale of 1 : 6500

How many **metres** are represented by a length of 3.8 cm on the map?

[2 marks]

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Answer \_\_\_\_\_ m

5 The number of foxes in England is expected to **increase** by 2% each year.  
Assume there are now 357 000 foxes in England.

Work out the expected number of foxes in England after **six** years.

You **must** show your working.

[3 marks]

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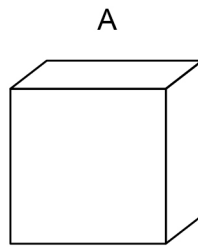
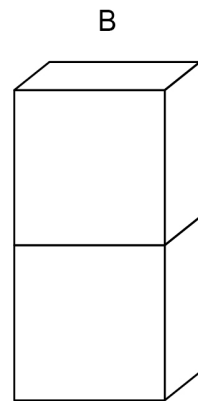
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Answer \_\_\_\_\_

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

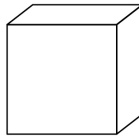
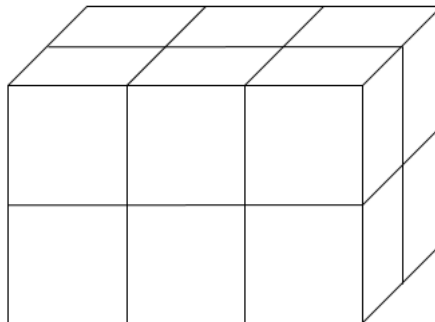
Give a reason for your answer.

**[2 marks]**

Cuboid A is formed of 6 faces, whereas cuboid B is formed of 10 of these faces, without the two which are joined.

6

Here is a cube A.

**A**Not drawn  
accuratelyCuboid B is made from **twelve** of cube A.**B**

volume of A : volume of B = 1 : 12

Henry says,

“surface area of A : surface area of B must be 1 : 12 because cuboid B is made of 12 of A.”

Is Henry correct?

Tick **one** box.
☐

Yes

☐

No

☐

Cannot tell

Give a reason for your answer.

**[2 marks]**


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**Turn over ►**

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

[2 marks]

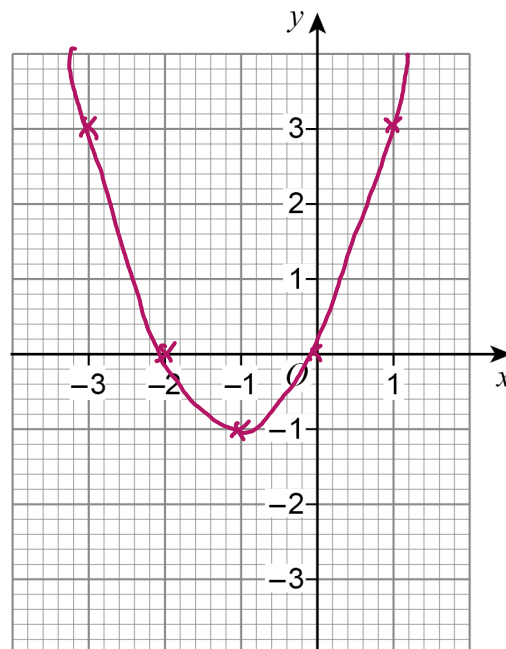
$x$	-3	-2	-1	0	1
$y$	3	0	-1	0	3

$$(-2)^2 + 2(-2) \\ = 4 + (-4) = 0$$

$$(1)^2 + 2(1) \\ = 1 + 2 = 3$$

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

[2 marks]





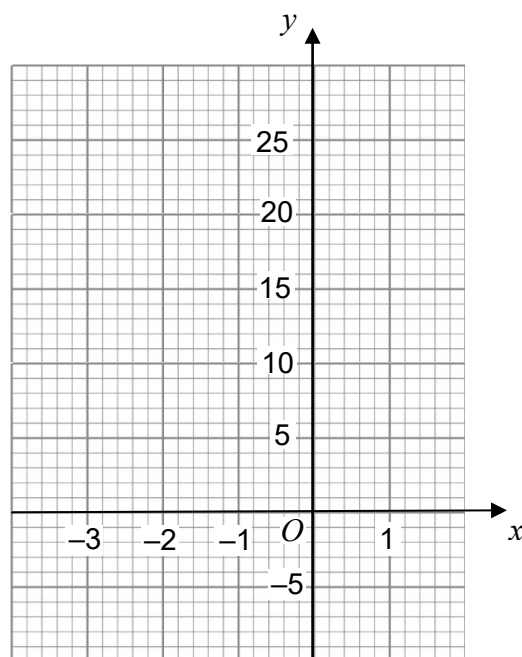
- 7 (a) Complete the table of values for  $y = x^2 - 4x$

[2 marks]

$x$	-3	-2	-1	0	1
$y$	21		5	0	

- 7 (b) Draw the graph of  $y = x^2 - 4x$  for values of  $x$  from -3 to 1

[2 marks]



Turn over ►

**[4 marks]**

Yes.

8

Shirley has £5625

She saves some and donates the rest to charity.

money saved : money given to charity = 2 : 7

She gives each of **five** charities the **same** amount.

Does each charity receive more than £870 ?

You **must** show your working.

[4 marks]

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Turn over ►

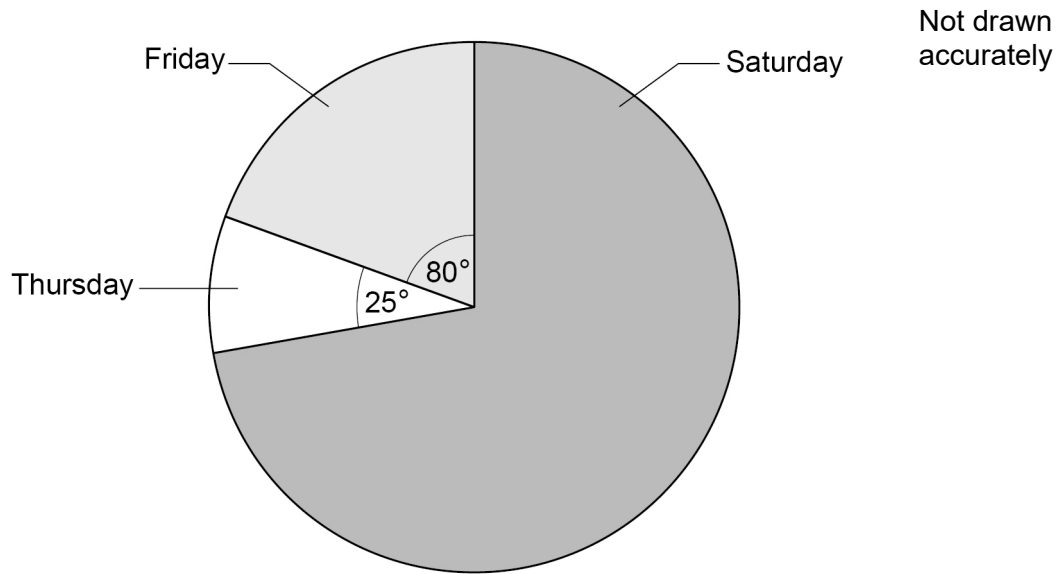
Shadow paper based on June 2023 question paper

8300/3H

9

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

Do not write  
outside the  
box



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

Work out the number of people on Saturday.

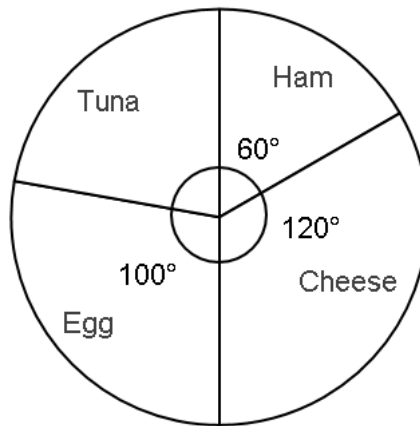
[3 marks]

$$\begin{array}{r}
 80^\circ - 25^\circ : 55^\circ \quad \div 11 \quad \left| \begin{array}{r} 55^\circ \\ 5^\circ \\ 255^\circ \end{array} \right| \begin{array}{r} 132 \text{ people} \\ 12 \\ 612 \end{array} \quad \downarrow \div 11 \\
 360^\circ - (80^\circ + 25^\circ) : 255^\circ \quad \times 51 \quad \left| \begin{array}{r} 55^\circ \\ 5^\circ \\ 255^\circ \end{array} \right| \begin{array}{r} 132 \text{ people} \\ 12 \\ 612 \end{array} \quad \downarrow \times 51
 \end{array}$$

Answer 612

9

The pie chart shows information about customers choice of sandwich filling.



Not drawn  
accurately

12 **more** customers chose egg than chose ham.

Work out the number of customers who chose tuna.

[3 marks]

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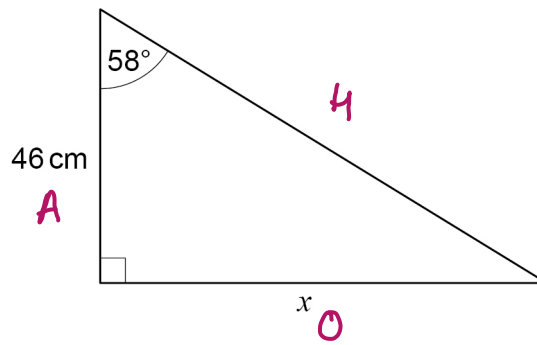
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Answer \_\_\_\_\_

10

Use trigonometry to work out the value of  $x$ .Not drawn  
accurately

[3 marks]

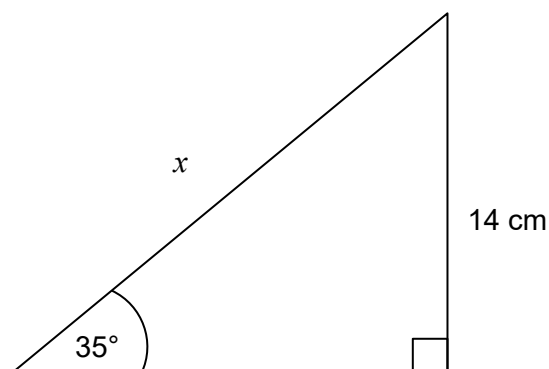
$$\tan \theta = \frac{O}{A}$$

$$\tan(58^\circ) = \frac{x}{46}$$

$$\tan(58) \times 46 = x = 73.615388336$$

$$x = 73.62 \text{ cm}$$

10

Use trigonometry to work out the value of  $x$ .Not drawn  
accurately**[3 marks]**

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 $x =$  \_\_\_\_\_ 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]

$$\frac{1}{(\sqrt[3]{8})^2 \times 10} \div \frac{1}{2^2 \times 10} \div \frac{1}{40}$$

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]

Because each value was rounded down to estimate, the exact value is a division by a larger denominator, leading to a smaller value.



- 11 Aiza is estimating the value of  $\frac{2}{(\sqrt{4.36})^3 \times 5.49}$
- She rounds each decimal number to 1 significant figure.

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

[2 marks]

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Answer \_\_\_\_\_

- 11 (b) Aiza says,  
"My estimate must be larger than the exact value."  
**Without working out the exact value**, give a reason how she can know this.

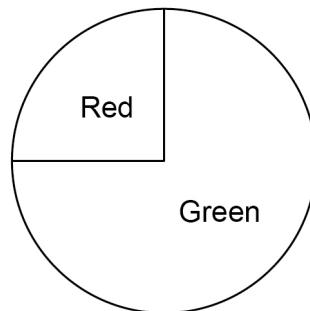
[1 mark]

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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, because he conducted the most trials.

**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]

$$80 \times 0.185 = 14.8$$

Dev cannot have spun 'red' 14.8 times - this should be 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]

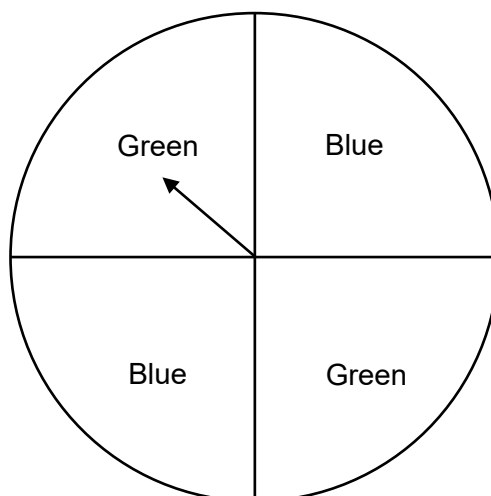
$$\text{Relative frequency of green} = 1 - 0.32 = 0.68$$

$$0.68 \times 125 = 85$$

Answer 85

Turn over ►

**12** Here is a **biased** spinner.



**12 (a)** Ann, Bill and Celine want to know the probability of spinning blue on the biased spinner. They each spin it and count how many times it lands on blue and divide by the total number of spins.

Ann says

I spun blue the most times

Bill says

I spun the spinner the most times

Celine says

My relative frequency of blue is 0.50

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

Give a reason for your answer.

**[1 mark]**

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**12 (b)** David spins the spinner 100 times.

He says,

“My relative frequency of blue is  $\frac{1}{3}$ ”

Give a reason why his relative frequency must be wrong.

**[1 mark]**

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**12 (c)** Emily spins the spinner 175 times.

The relative frequency of blue is 0.64

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

**[2 marks]**

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Answer \_\_\_\_\_

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]

$$\frac{176}{48} = 3.6\dot{6} = 3 \text{ hrs } 40 \text{ minutes}$$

$$(3\frac{2}{3})$$

$$293 - 176 = 117$$

$$\frac{117}{65} = 1.8 = 1 \text{ hr } 48 \text{ minutes}$$

$$(1\frac{4}{5})$$

$$3 \text{ hrs } 40 \text{ mins} + 1 \text{ hr } 48 \text{ mins} = 4 \text{ hrs } 88 \text{ mins} = 5 \text{ h } 28 \text{ mins}$$

$$9 \text{ am} + 5 \text{ h } 28 \text{ m} = 14:28 = 2.28 \text{ pm}$$

Yes.

Daniel is driving 154 miles to visit his aunt.

- leaves at 8.15 am
- travels the first 90 miles at an average speed of 50 mph
- drives the rest of the way at an average speed of 47 mph.

You **must** show your working.

**[4 marks]**

14

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

**Income Tax**

0% of the first £12 570 of her annual salary  
20% of the rest of her annual salary

**National Insurance**

0% of the first £9 880 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]**

$$\begin{array}{r|l} \text{£5186} & 20\% \\ \hline \text{£25,930} & 100\% \end{array} \quad \begin{array}{l} \text{Taxable salary} \\ \text{Taxable salary} \end{array}$$

$$25\,930 + 12\,570 = \text{£}38,500 \text{ salary}$$

$$38\,500 - 9\,880 = \text{£}28,620$$

$$28\,620 \times 0.1325 = \text{£}3,792.15$$

Answer £ 3,792.15



Stephanie paid Income Tax and National Insurance on her annual salary.

0% of the first £14 700 of her annual salary  
20% of the rest of her annual salary

0% of the first £6500 of her annual salary  
15.75% of the rest of her annual salary

How much National Insurance did she pay?

**[4 marks]**

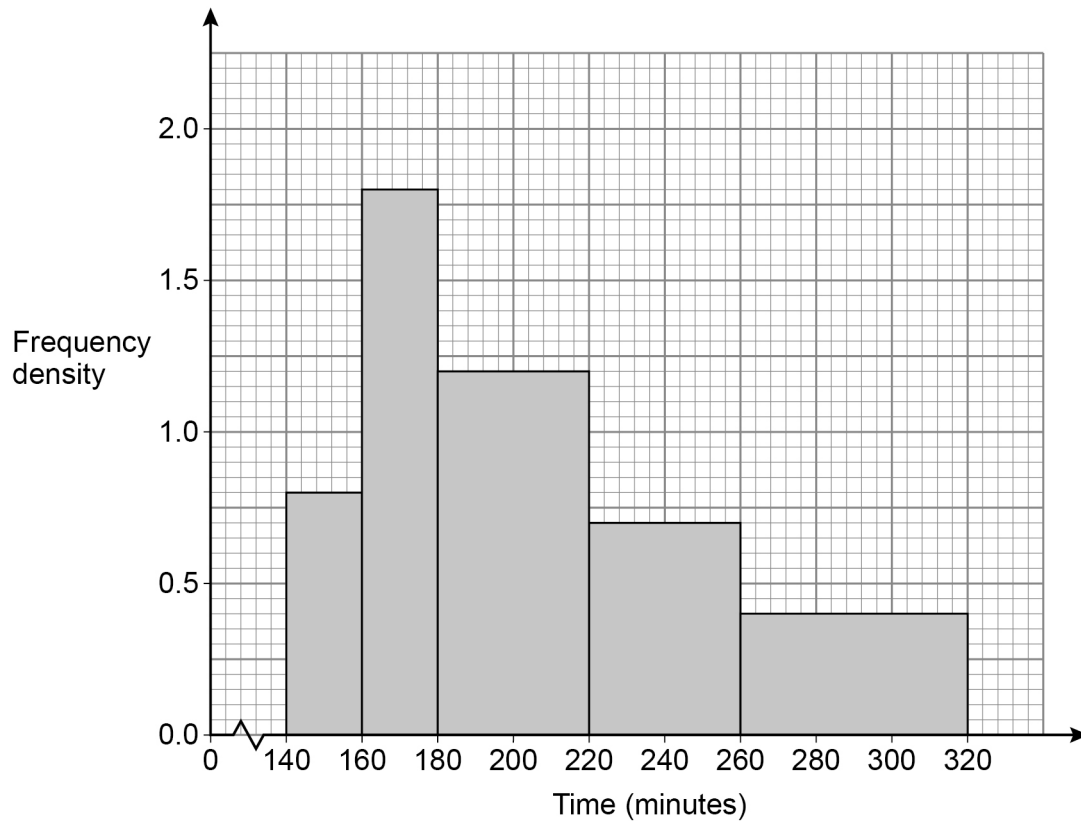
Answer £ \_\_\_\_\_

4

**Turn over ►**

- 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]

$$20 \times 0.8 = 16$$

$$20 \times 1.8 = 36$$

$$40 \times 1.2 = 48$$

$$40 \times 0.7 = 28$$

$$60 \times 0.4 = 24$$

142 finishers

$$180 - 142 = 38$$

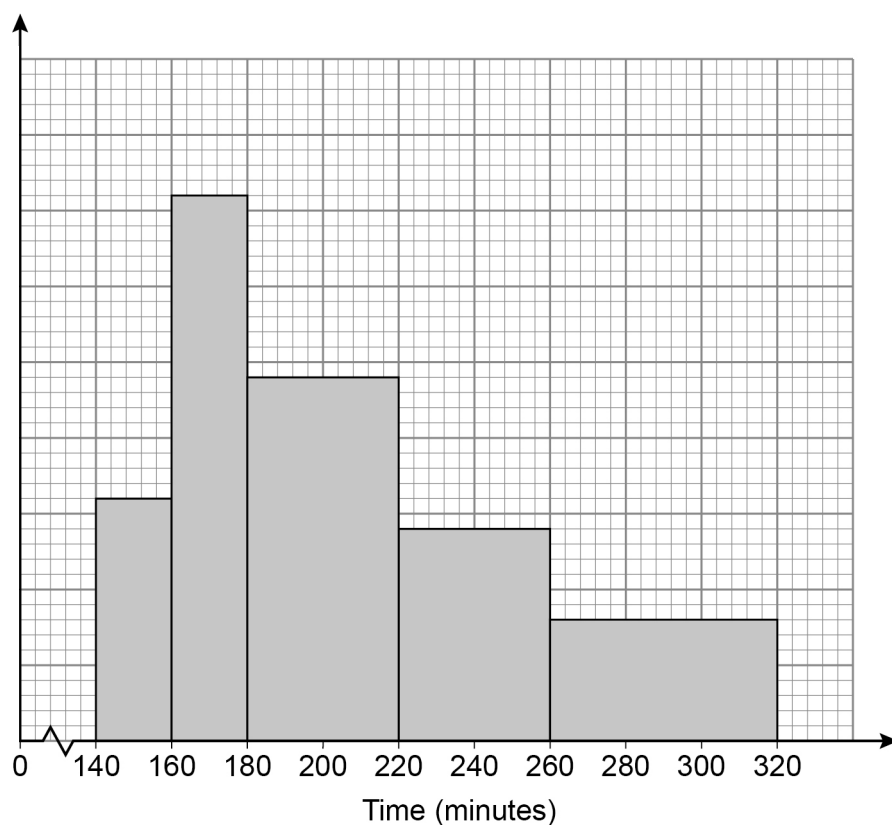
Answer

38

**15** Some runners from Coventry Running Club entered a marathon.

**15 (a)** The histogram represents the times of the runners from the club who completed the marathon.

48 runners finished the marathon between 260 and 320 minutes.



How many runners finished in under 220 minutes?

**[3 marks]**

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Answer \_\_\_\_\_

3

**Turn over ►**

- 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

$$\begin{aligned} \text{Upper quartile} &= \text{LQ} + \text{IQR} \\ &= 11 + 9 = 20 \end{aligned}$$

Draw a box plot to represent the information.

[3 marks]

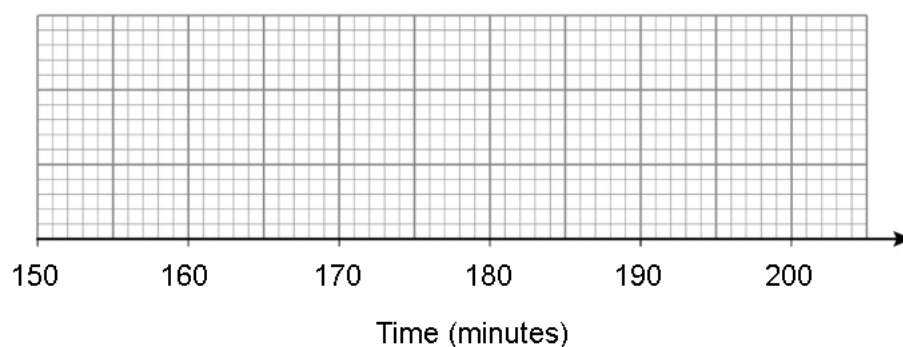


- 15 (b)** The table shows information about the runners who completed the marathon from Leicester Running Club.

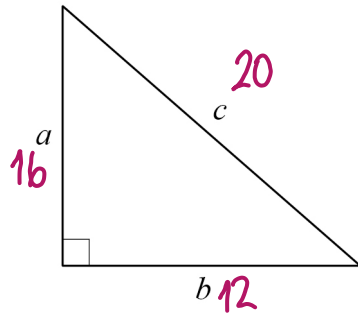
	<b>Time (minutes)</b>
Least time	150
Greatest time	200
Lower quartile	163
Median	172
Interquartile range	24

Draw a box plot to represent the information.

**[3 marks]**



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]

$$\begin{array}{l} \times 4 \quad \downarrow 4.5 \quad \downarrow \times 5 \\ 16 : 20 \end{array}$$

$$20^2 - 16^2 : 400 - 256 : 144$$

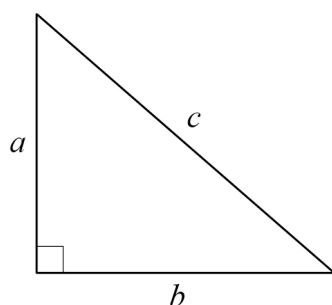
$$b^2 : 144$$

$$b : \sqrt{144} = 12$$

$$\text{Area} : \frac{bh}{2} : \frac{16 \times 12}{2} : 96$$

Answer 96 cm<sup>2</sup>

Not drawn  
accurately


$$c = 39 \text{ cm}$$

$$c : a = 13 : 5$$

Work out the area of the triangle.

**[4 marks]**

Answer \_\_\_\_\_  $\text{cm}^2$

17

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

[4 marks]

$$\frac{x+8}{2} + \frac{9-x}{5} = \frac{5(x+8)}{10} + \frac{2(9-x)}{10}$$

$$= \frac{5x+40+18-2x}{10} = \frac{3x+58}{10}$$

$$\frac{3x+58}{10} = 4$$

$$\times 10 \quad \times 10$$

$$3x+58 = 40$$

$$-58 \quad -58$$

$$3x = -18$$

$$\div 3 \quad \div 3$$

$$x = -6$$

$$x = -6$$



17

Solve  $\frac{x-4}{3} + \frac{10-x}{4} = 1$

**[4 marks]**

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 $x =$  \_\_\_\_\_

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4**Turn over ►**

18  $f(x) = x^2 + 6x$   
 $g(x) = 2x + 4$

18 (a) Show that  $fg(x) = 4x^2 + 28x + 40$

[3 marks]

$$\begin{aligned} fg(x) &= f(g(x)) \\ &= g(x)^2 + 6(g(x)) \\ &= (2x+4)^2 + 6(2x+4) \\ &= 4x^2 + 16x + 16 + 12x + 24 \\ &= 4x^2 + 28x + 40. \end{aligned}$$

18 (b) Solve  $fg(x) = -5$

[3 marks]

$$4x^2 + 28x + 40 = -5$$

$$4x^2 + 28x + 45 = 0$$

$$(2x+9)(2x+5) = 0$$

$$\begin{array}{rcl} 2x+9 & = & 0 \\ -9 & -9 & \\ 2x & = & -9 \\ \div 2 & \div 2 & \\ x & = & -4.5 \end{array}$$

$$\begin{array}{rcl} 2x+5 & = & 0 \\ -5 & -5 & \\ 2x & = & -5 \\ \div 2 & \div 2 & \\ x & = & -2.5 \end{array}$$

Answer  $x = -4.5, x = -2.5$

**18**  $f(x) = 3x^2 - x$   
 $g(x) = x + 3$

**18 (a)** Show that  $fg(x) = 3x^2 + 17x + 24$

**[3 marks]**

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**18 (b)** Solve  $fg(x) = 5$

Give your answers correct to 2 decimal places.

**[3 marks]**

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Answer \_\_\_\_\_

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]**

$$x \text{ and } x+6$$

$$x(x+6) = x^2 + 6x$$

$$x^2 + 6x + 9$$

$$x^2 + 6x + 9 = (x+3)^2$$

**19**

Two integers have a difference of 2

The integers are multiplied together.

1 is then added.

Prove algebraically that the result is always a square number.

**[3 marks]**

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- 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  $2 \leq D \leq 6$



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

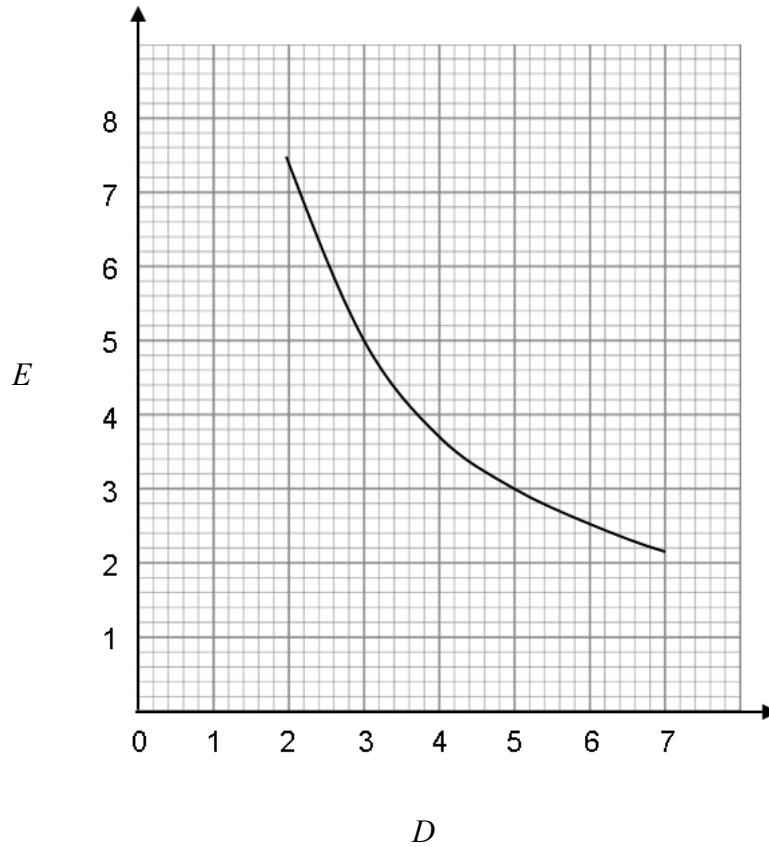
[1 mark]

$(5, 7)$   $D=5, E=7$   $\frac{36}{5} = 7.2$

Sunil's equation is not correct.

- 20 (a)** Sunil thinks that  $E$  and  $D$  are linked by the equation  $E = \frac{14}{D}$

The graph shows the values of  $D$  and  $E$  for  $2 \leq D \leq 7$



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

**[1 mark]**

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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]

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

$$G = k\sqrt{H}$$

$$\begin{array}{l} \nearrow 8 \downarrow 3:2 \searrow \nearrow 8 \\ 24:16 \end{array}$$

$$24 = k \times \sqrt{16}$$

$$24 = k \times 4$$

$$k = 6$$

$$G = 6\sqrt{H}$$

$$H = 100 \quad G = 6 \times \sqrt{100} = 6 \times 10 = 60$$

$$\begin{array}{l} G:H = 60:100 \searrow \nearrow 20 \\ 3:5 \end{array}$$

Answer 3 : 5



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

$$G : H = 5 : 1 \quad \text{when} \quad H = 10$$

Work out  $G : H$  when  $H = 20$

**[4 marks]**

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Answer \_\_\_\_\_ : \_\_\_\_\_

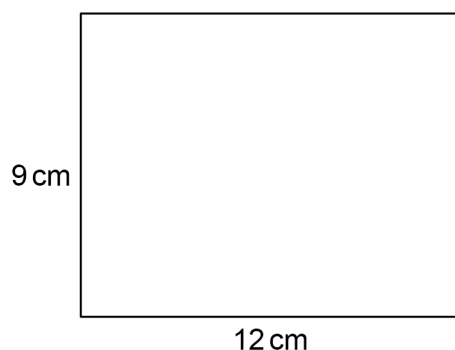
21

A solid shape is made from centimetre cubes.

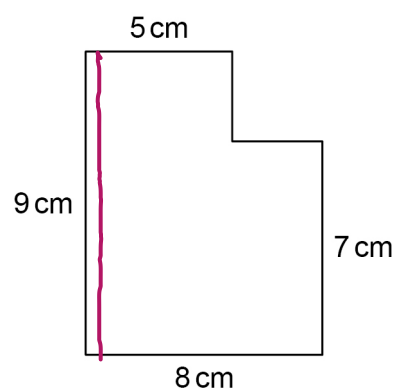
The front elevation and side elevation of the shape are shown.

Not drawn  
accurately

Front elevation



Side elevation



Work out

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

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

[3 marks]

$$\begin{aligned} \text{Maximum} &: \text{Area of side} \times \text{length} \\ &: (8 \times 9 - 2 \times 3) \times 12 \\ &: (72 - 6) \times 12 = 792 \end{aligned}$$

$$\begin{aligned} \text{Minimum} &: 1 \text{ cube thick front} \\ &+ 1 \text{ cube thick side} \\ &: (9 \times 12) + (7 \times 9 - 2 \times 3) \\ &: 108 + 57 \\ &: 165 \end{aligned}$$

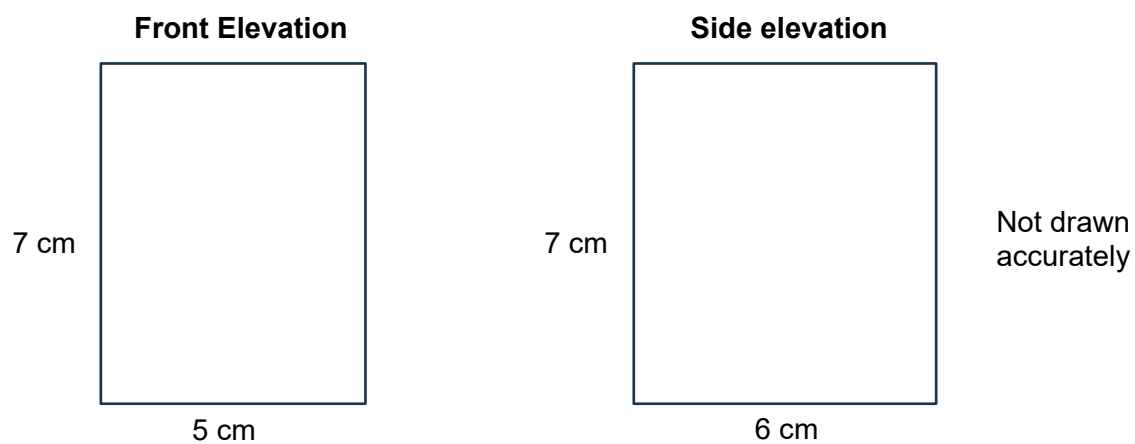
Maximum 792

Minimum 165

21

A solid shape is made from centimetre cubes.

The front elevation and side elevation of the shape are shown.



Work out

the **maximum** possible number of cubes in the shape

and

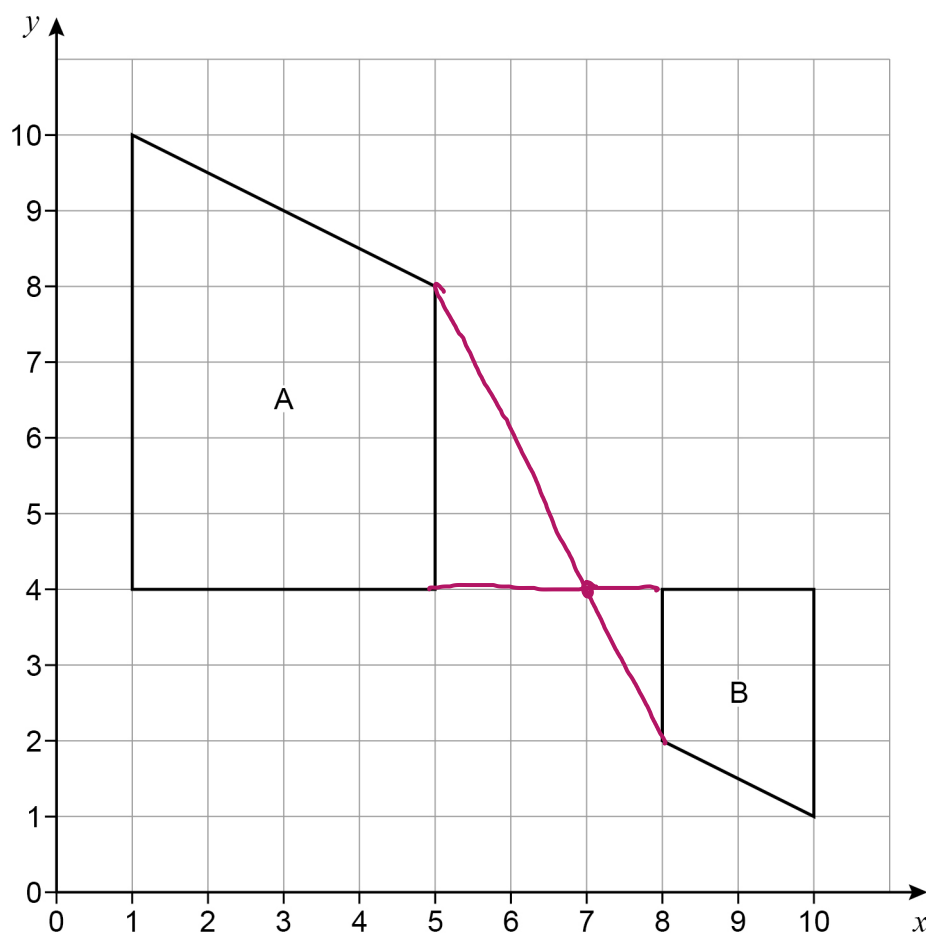
the **minimum** possible number of cubes in the shape.

**[3 marks]**

Maximum \_\_\_\_\_ Minimum \_\_\_\_\_

22

Shape A and shape B are shown on the grid.

Do not write  
outside the  
boxDescribe the **single** transformation that maps shape A to shape B.**[3 marks]**

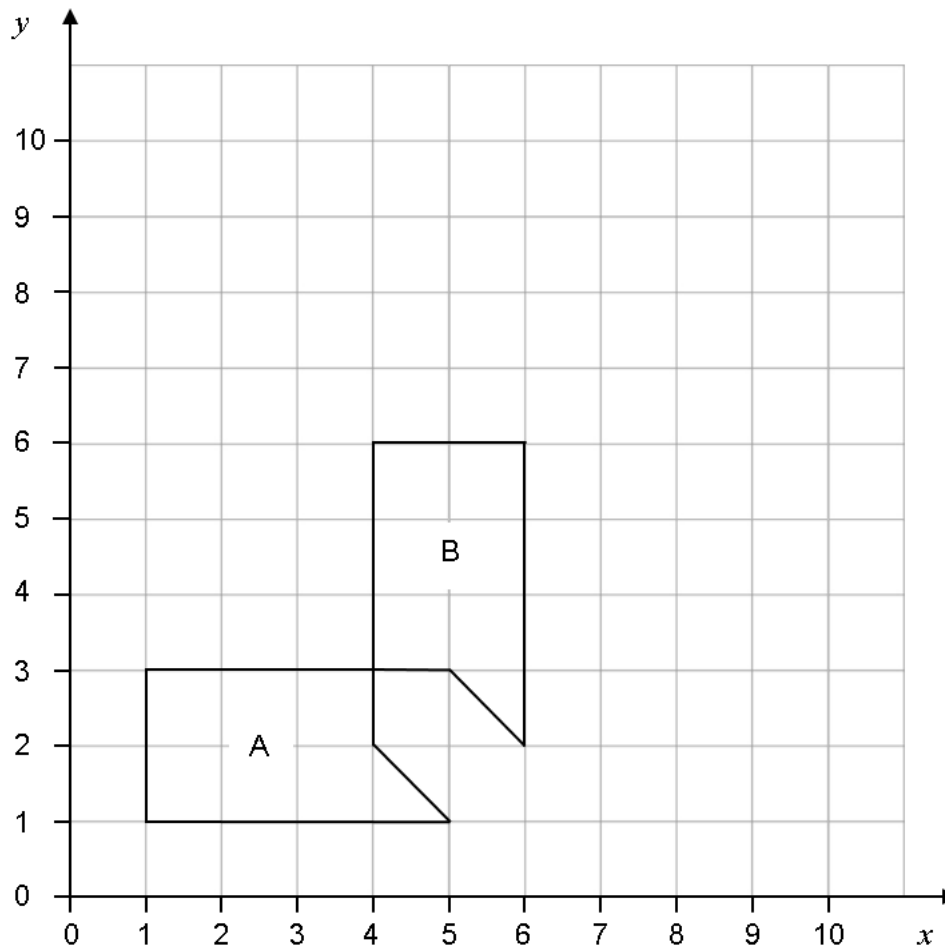
Enlargement

Scale factor  $-\frac{1}{2}$ 

Centre (7, 4)

22

Shape A and shape B are shown on the grid.

Describe the **single** transformation that maps shape A to shape B.**[3 marks]**

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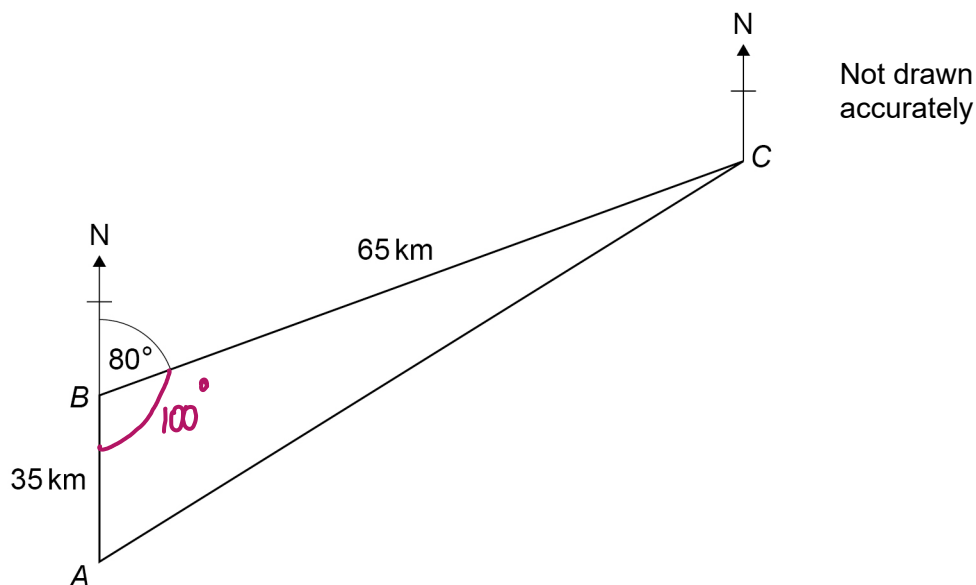
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23



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]

$$c^2 = a^2 + b^2 - 2ab \cos C$$

$$AC^2 = 35^2 + 65^2 - 2 \times 35 \times 65 \times \cos 100$$

$$= 6420.099208385$$

$$AC = \sqrt{6420.099208385} = 78.994298582 \text{ km}$$

$$= 79 \text{ km}$$

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

[4 marks]

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

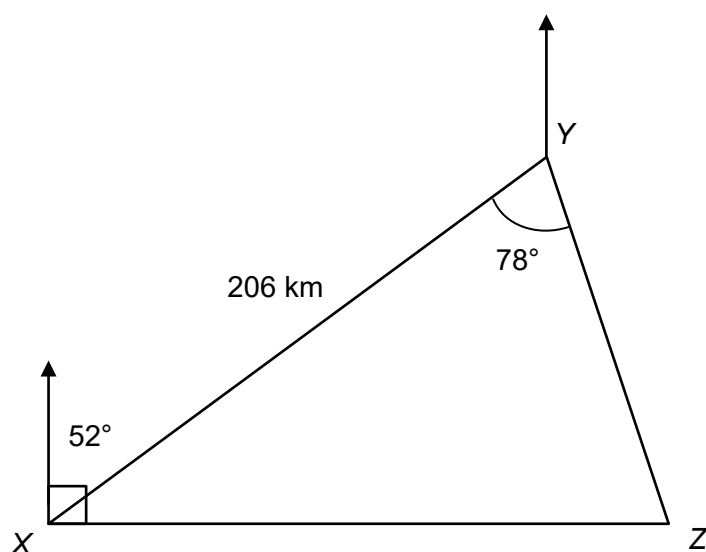
$$\cos A = \frac{35^2 + 79^2 - 65^2}{2 \times 35 \times 79}$$

$$A = \cos^{-1} \left( \frac{35^2 + 79^2 - 65^2}{2 \times 35 \times 79} \right) = 54.120962679$$

Answer 54.1 °

Turn over ►

23

Not drawn  
accurately

A plane flies 206 km on a bearing of  $052^\circ$  from  $X$  to  $Y$ .

From  $Y$  the plane flies to  $Z$ , which is due East of  $X$ , and then back to  $X$ .

- 23 (a)** Show that the distance the plane flies from  $Y$  to  $Z$  is 141 km to the nearest km.  
You **must** show your working.

**[2 marks]**


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**[4 marks]**

Answer

**END OF QUESTIONS**