

Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Candidate signature \_\_\_\_\_

I declare this is my own work.

# GCSE MATHEMATICS

# H

Higher Tier

Paper 1 Non-Calculator

Shadow paper based on November 2021 question paper

Time allowed: 1 hour 30 minutes

### Materials

For this paper you must have:

- mathematical instruments



You must **not** use a calculator.

### 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.

### Advice

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

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	
26	
<b>TOTAL</b>	

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

- 1** Simplify  $(x^3)^7$   
Circle your answer. **[1 mark]**

$10x$

$21x$

$x^{10}$

$x^{21}$

- 2**  $p \neq 0.6$   
Circle the possible value of  $p$ . **[1 mark]**

$\frac{6}{10}$

$\frac{30}{50}$

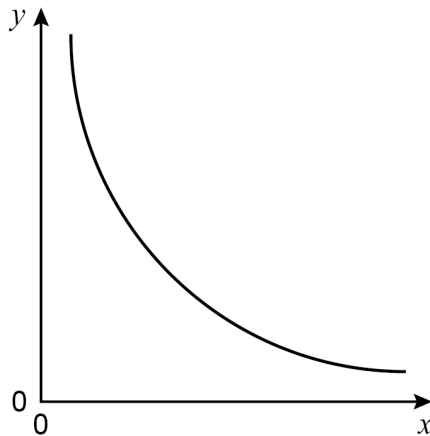
$\frac{45}{70}$

$\frac{180}{300}$

- 3** Circle the solid that has 9 vertices. **[1 mark]**

octagonal  
prismoctagon-based  
pyramidhexagonal  
prismhexagon-based  
pyramid

- 4 Here is a sketch of a graph.



Circle the equation of the graph.

[1 mark]

$$y = x$$

$$y = 1 + x$$

$$y = \frac{1}{x}$$

$$y = 1 - x$$

- 5 Write 360 as a product of prime factors.  
Give your answer in index form.

[3 marks]

Answer \_\_\_\_\_

6 Adam's age is 3 years and 6 months.

Zara's age is 2 years and 11 months.

Write Adam's age in months as a fraction of Zara's age in months.

Give your fraction in its simplest form.

[2 marks]

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Answer \_\_\_\_\_

7 Use approximations to estimate the answer to

$$\frac{\sqrt{145} + 3.017^2}{2.95}$$

[3 marks]

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Answer \_\_\_\_\_

8 (a) Solve  $7x + 3 > 5x + 10$

[3 marks]

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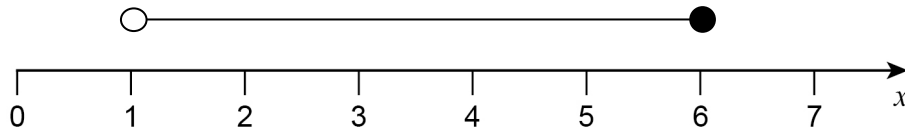
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Answer \_\_\_\_\_

8 (b) Write down the inequality represented by the number line.

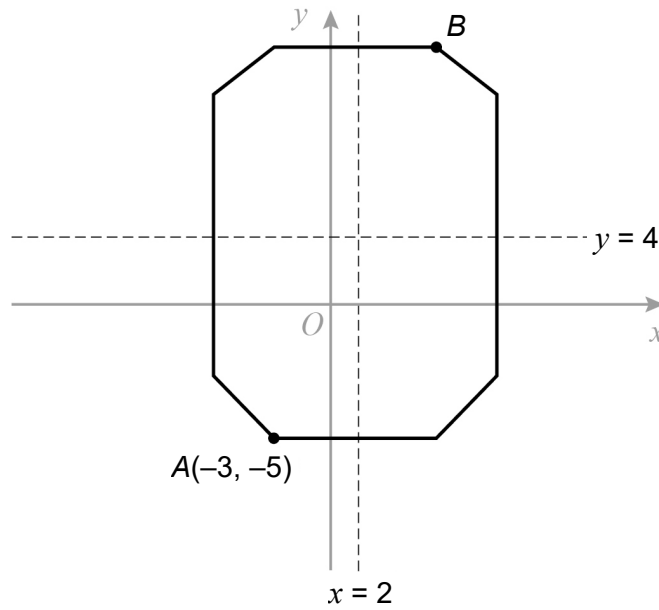


[2 marks]

Answer \_\_\_\_\_

9

The diagram shows an octagon.

Not drawn  
accurately

$x = 2$  and  $y = 4$  are lines of symmetry.

Work out the coordinates of point  $B$ .

**[2 marks]**


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

- 10 (a)** Work out  $3000 \times 60\,000$   
Give your answer in standard form.

**[2 marks]**

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Answer \_\_\_\_\_

- 10 (b)** Work out  $\frac{2.1 \times 10^3}{3 \times 10^{-2}}$   
Give your answer as an ordinary number.

**[2 marks]**

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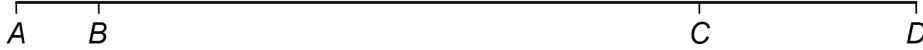
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Answer \_\_\_\_\_

- 11  $A$ ,  $B$ ,  $C$  and  $D$  are markers on a park run route.

Not drawn  
accurately



distance  $CD = 2 \times$  distance  $AB$

distance  $BC = 4$  km

Sheena runs from  $A$  to  $C$ .

She runs for 30 minutes at an average speed of 14 km per hour.

Work out the distance  $AD$ .

[4 marks]

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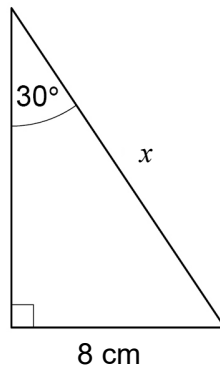
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Answer \_\_\_\_\_ km

12 Here is a right-angled triangle.



Not drawn  
accurately

Use trigonometry to work out the value of  $x$ .

[3 marks]

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Answer \_\_\_\_\_ cm

Turn over for the next question

13 Convert  $\frac{5}{9}$  to a recurring decimal.

[2 marks]

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Answer \_\_\_\_\_

14 Simplify  $\frac{4}{x+1} + \frac{5}{x+1}$

Circle your answer.

[1 mark]

$$\frac{9}{x+1}$$

$$\frac{9}{2(x+1)}$$

$$\frac{20}{x+1}$$

$$\frac{20}{(x+1)^2}$$

15

$$(x + a)(x + 2a) \equiv x^2 + bx + 128$$

Work out the **two** possible values of  $b$ .

**[3 marks]**

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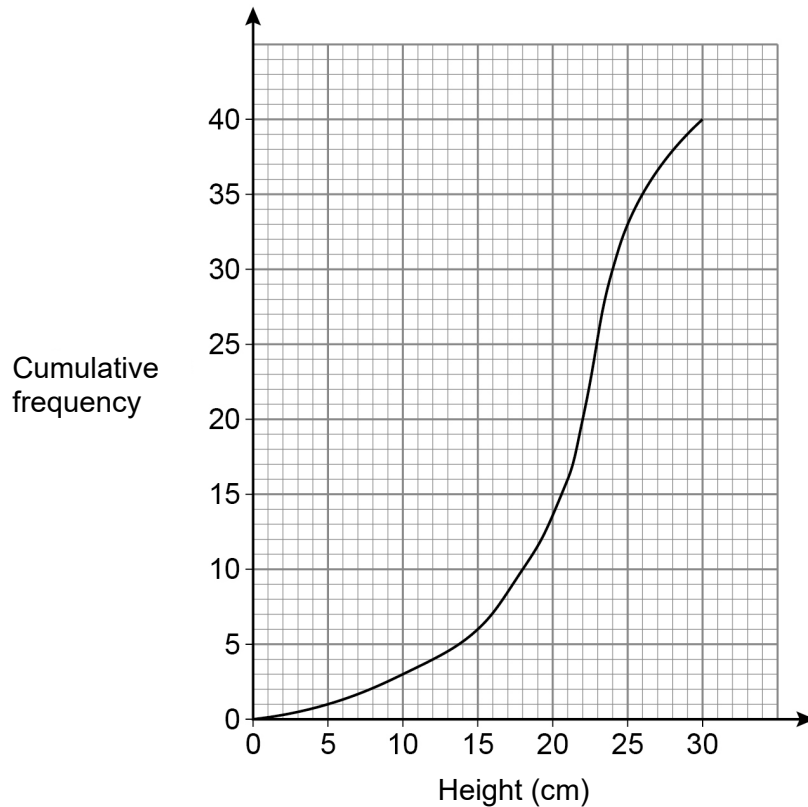
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Answer \_\_\_\_\_ and \_\_\_\_\_

- 16 The cumulative frequency graph represents the heights of 40 vases.



- 16 (a) A dealer buys every vase with height **greater than** 26 cm.

Use the graph to estimate how many she buys.

**[2 marks]**

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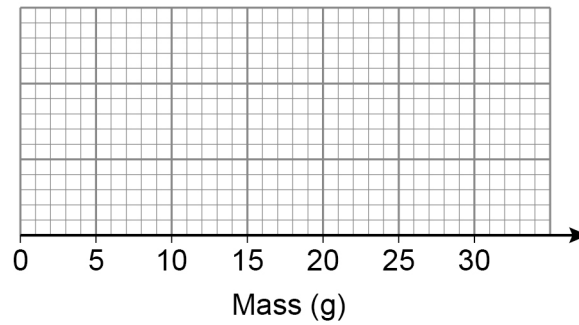
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Answer \_\_\_\_\_

- 16 (b)** The lowest height was 8 cm.  
The greatest height was 28 cm.  
Draw a box plot to represent the data.

**[3 marks]**

- 17** Circle the vector that translates the point  $(4, -5)$  to the point  $(-3, 1)$

**[1 mark]**

$$\begin{pmatrix} -7 \\ 4 \end{pmatrix}$$

$$\begin{pmatrix} -7 \\ 6 \end{pmatrix}$$

$$\begin{pmatrix} 7 \\ -4 \end{pmatrix}$$

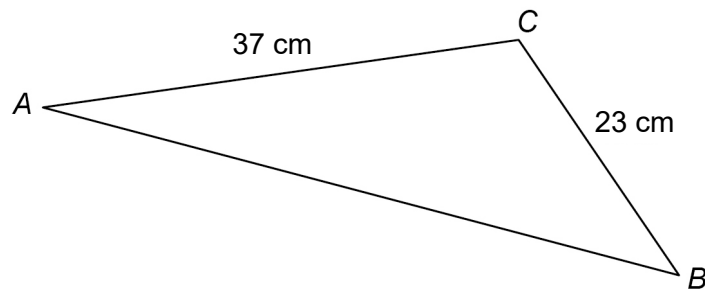
$$\begin{pmatrix} 7 \\ -6 \end{pmatrix}$$

**Turn over for the next question**

**Turn over ►**

18 (a) Here is a triangle.

Not drawn  
accurately



Give a reason why the length of side  $AB$  **cannot** be 60 cm

[1 mark]

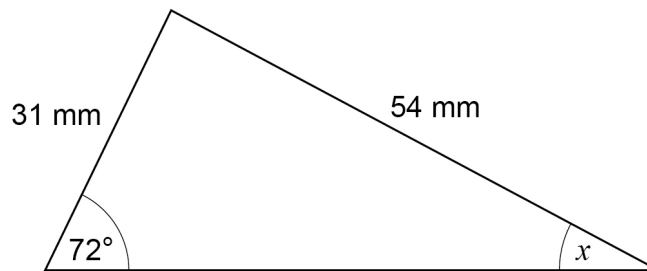
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18 (b) Here is a different triangle.



Not drawn  
accurately

Penny tries to use the sine rule to work out the size of angle  $x$ .

Here are the first two lines of her working.

$$\frac{\sin x}{31} = \frac{54}{\sin 72}$$

$$\sin x = \frac{31 \times 54}{\sin 72}$$

What error has she made in this working?

[1 mark]

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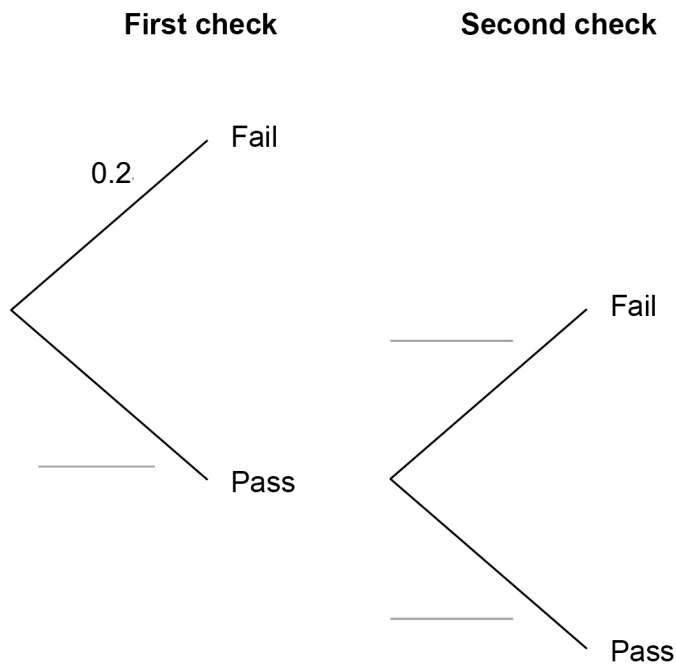
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- 19** Apples intended for a supermarket have to pass two checks.
- 20% of apples fail the first check.  
The apples that fail are thrown away.
- 95% of the apples that pass the first check pass the second check.  
The apples that fail are thrown away.

**19 (a)** Complete the tree diagram.

**[2 marks]**



**19 (b)** An apple is chosen at random before the checks.

Work out the probability that the apple is thrown away.

**[3 marks]**

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Answer \_\_\_\_\_

**20** Which **one** of these is a unit of acceleration?

Circle your answer.

**[1 mark]**

$\text{m}^2/\text{s}$

$\text{m}/\text{s}^2$

$\text{s}/\text{m}^2$

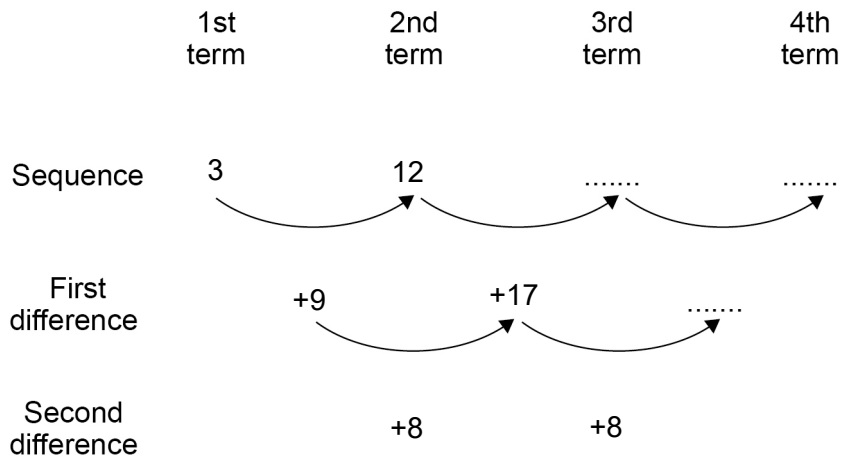
$\text{s}^2/\text{m}$

**Turn over for the next question**

21

The first two terms of a quadratic sequence are 3 and 12

Here is some information about the sequence.



Work out an expression for the  $n$ th term of the sequence.

**[4 marks]**

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Answer \_\_\_\_\_

22 Work out the value of  $\left(\frac{2}{3}\right)^{-3}$

Give your answer as a mixed number.

[3 marks]

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Answer \_\_\_\_\_

23 Rearrange  $y = \frac{1}{x^2 + 2}$  to make  $x$  the subject.

[3 marks]

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Answer \_\_\_\_\_

**24 (a)**  $f(x) = ax + 2b$

$$f(6) = 17$$

$$f(10) = 31$$

Work out the values of  $a$  and  $b$ .

**[3 marks]**

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$$a = \underline{\hspace{4cm}} \quad b = \underline{\hspace{4cm}}$$

24 (b)  $g(x) = 3x$  and  $h(x) = \frac{x+2}{3}$

Circle the expression for  $hg(x)$

[1 mark]

$$\frac{3x^2 + x}{3}$$

$$x^2 + 2x$$

$$\frac{3x+2}{3}$$

$$x + 2$$

25 Show that  $\frac{\sqrt{135} + \sqrt{15}}{\sqrt{3} \times \sqrt{5}}$  simplifies to an integer.

[3 marks]

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Turn over for the next question

Turn over ►

26

$$a = 3c$$

$$\frac{b-c}{a+b} = \frac{1}{6}$$

Work out the ratio  $b : c$

**[3 marks]**

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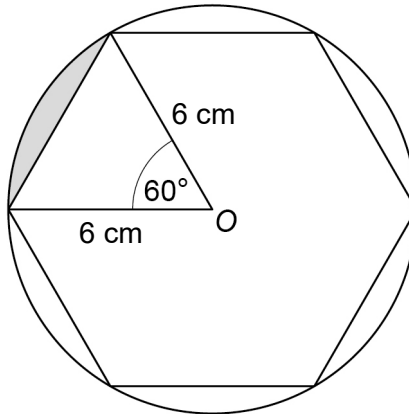
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Answer \_\_\_\_\_ : \_\_\_\_\_

27

The vertices of a regular hexagon lie on a circle with centre  $O$  and radius 6 cm

Not drawn  
accurately



Work out the shaded area.

Give your answer in the form  $a\pi - b\sqrt{3}$  where  $a$  and  $b$  are integers.

[4 marks]

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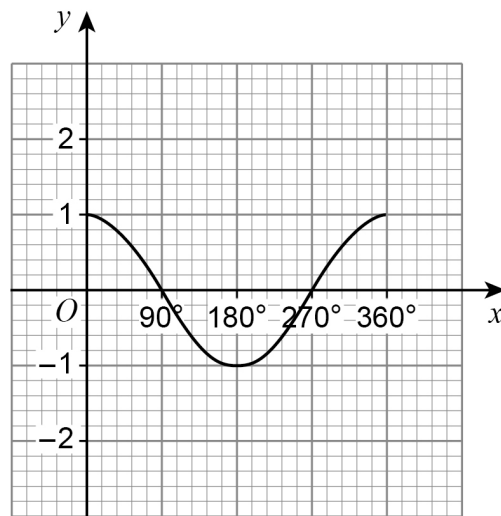
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Answer \_\_\_\_\_  $\text{cm}^2$

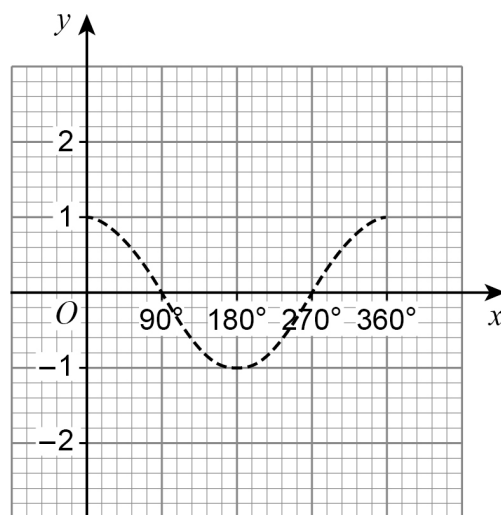
28 Here is the graph of  $y = \cos x$  for  $0^\circ \leq x \leq 360^\circ$



In parts (a) and (b) the graph of  $y = \cos x$  is shown as a dashed line.

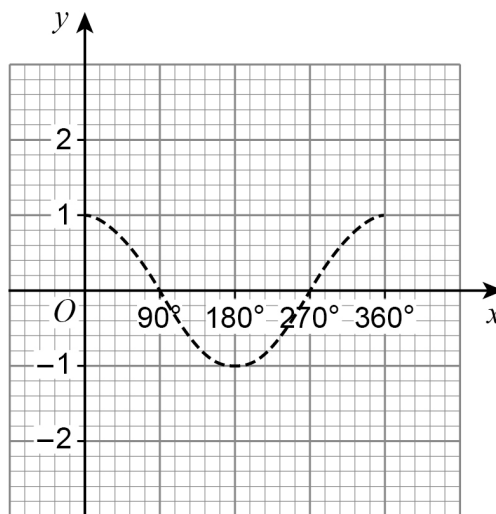
28 (a) On the grid below, draw the graph of  $y = \cos(x + 90^\circ)$  for  $0^\circ \leq x \leq 360^\circ$

[1 mark]



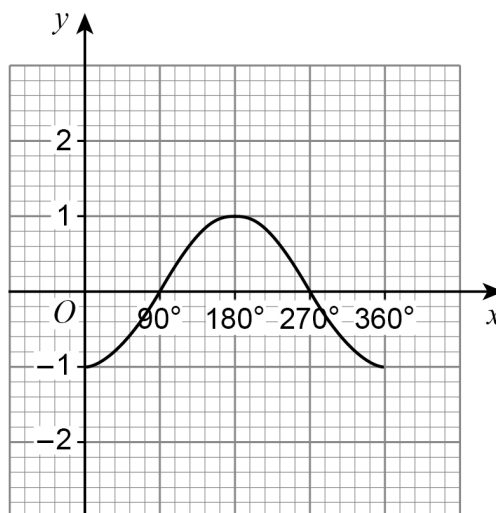
28 (b) On the grid below, draw the graph of  $y = \cos x - 1$  for  $0^\circ \leq x \leq 360^\circ$

[1 mark]



28 (c) Rita tries to draw the graph of  $y = \sin x$  for  $0^\circ \leq x \leq 360^\circ$

Here is her graph.



Give a reason why Rita's graph is incorrect.

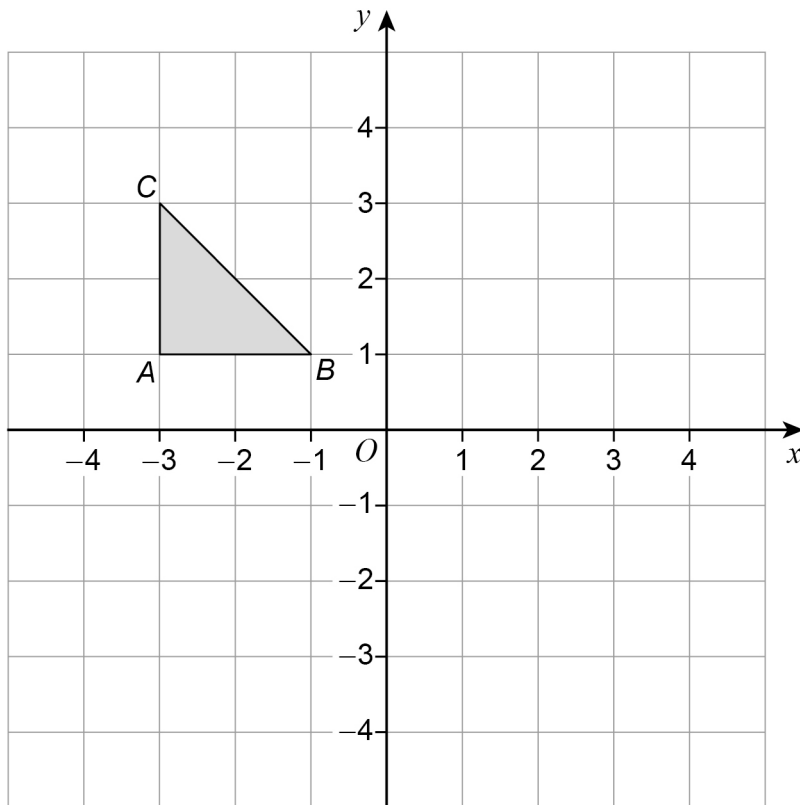
[1 mark]

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29

Here is triangle  $ABC$  on a grid.Describe a **single** transformation of the triangle so thatpoint  $B$  is invariantpoint  $A$  moves to  $(-1, -1)$ point  $C$  moves to  $(-3, -1)$ **[3 marks]**

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**END OF QUESTIONS**

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**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**









**There are no questions printed on this page**

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ANSWER IN THE SPACES PROVIDED**

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Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Candidate signature \_\_\_\_\_

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# GCSE MATHEMATICS

Higher Tier

Paper 2 Calculator

# H

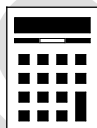
Shadow paper based on November 2021 question paper

Time allowed: 1 hour 30 minutes

## Materials

For this paper you must have:

- a calculator
- mathematical instruments.



## Instructions

- Use black ink or black ball-point pen. Draw diagrams in pencil.
- Fill in the boxes at the top of this page.
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6–7	
8–9	
10–11	
12–13	
14–15	
16–17	
18–19	
20–21	
22–23	
24	
<b>TOTAL</b>	

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

- 1** Circle the factor of  $x^2 + 2x$  **[1 mark]**

$x + 1$

$-2x$

$x + 2$

$2x$

- 2**  $B$  is one third of  $A$ .  
Work out the ratio  $A : B$   
Circle your answer. **[1 mark]**

$1 : 3$

$3 : 1$

$1 : 4$

$4 : 1$

- 3** The first three terms of a geometric progression are  $\frac{2}{5}$   $\frac{4}{25}$   $\frac{8}{125}$   
Circle the fourth term. **[1 mark]**

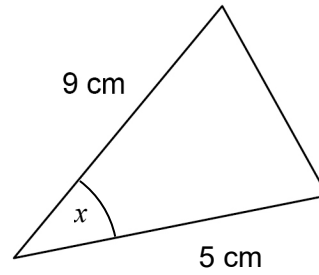
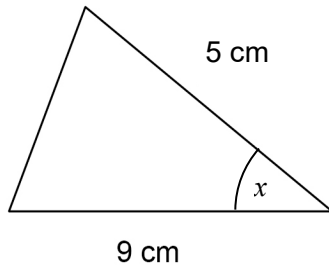
$\frac{10}{625}$

$\frac{12}{625}$

$\frac{16}{625}$

$\frac{32}{625}$

4

Not drawn  
accurately

Circle the reason why these triangles are congruent.

[1 mark]

ASA

RHS

SAS

SSS

5

Solve  $12x = 98.8 - 7x$ 

[2 marks]

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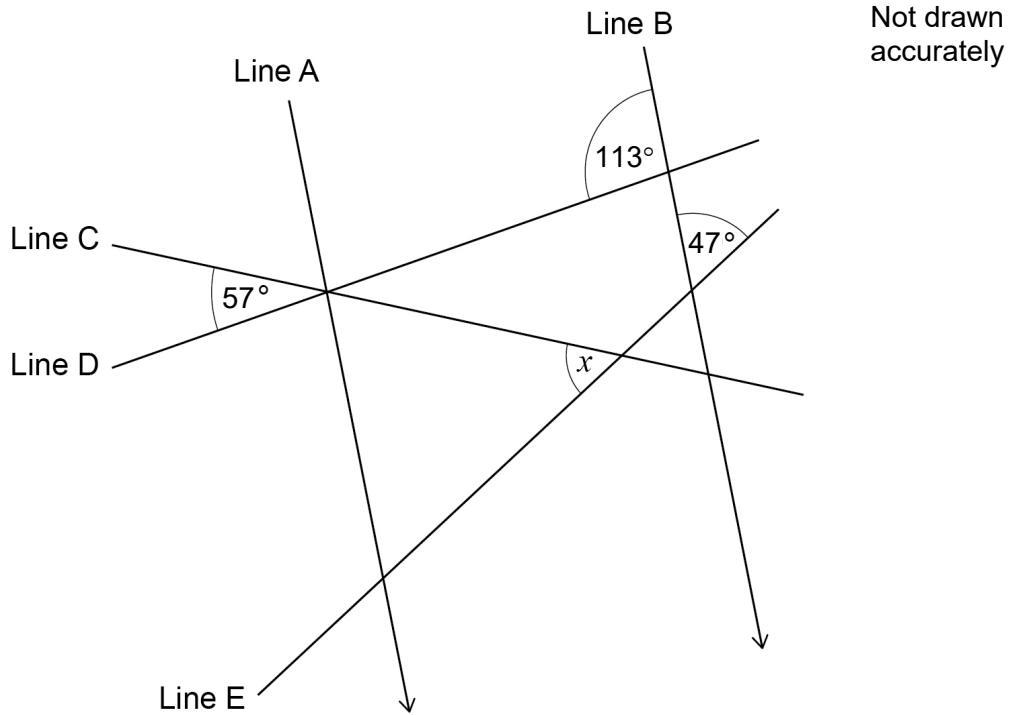
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 $x =$  \_\_\_\_\_

- 6** Lines A, B, C, D and E intersect as shown.  
Lines A and B are parallel.



Work out the size of angle  $x$ .

**[3 marks]**

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Answer \_\_\_\_\_ degrees

- 7 112 women and 95 men from Bolton went clothes shopping in February.  
The table shows information about the mean amount spent, in pounds, by each person.

	Women	Men
Number of people	112	95
Mean amount spent (£)	68.50	52.40

The national mean for clothes spending per person in February was £63.

Was the mean spend for the people in Bolton greater than the national mean in February?

You **must** show your working.

[3 marks]

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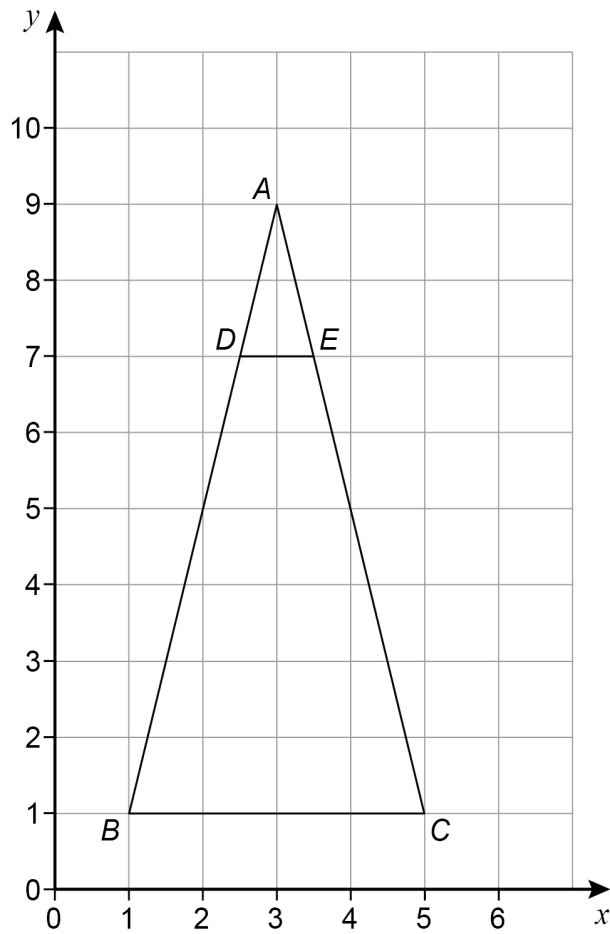
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Turn over ►

8



Describe fully the **single** transformation that maps triangle  $ADE$  to triangle  $ABC$ .

[3 marks]

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9

A ball contains  $3000 \text{ cm}^3$  of air.

More air is pumped into the ball at a rate of  $500 \text{ cm}^3$  per second.

The ball is full of air when it becomes a sphere with radius  $20 \text{ cm}$



$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3 \quad \text{where } r \text{ is the radius}$$

Does it take **less than** 1 minute to fill the ball?

You **must** show your working.

[4 marks]

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Turn over ►

10

 $a$  is a negative number. $b$  is a negative number.

For each statement, tick the correct box.

**[4 marks]**

	Always true	Sometimes true	Never true
$a + b$ is positive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
$a - b$ is positive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
$a^2 + b^2$ is positive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
$a^3 \div b^3$ is positive	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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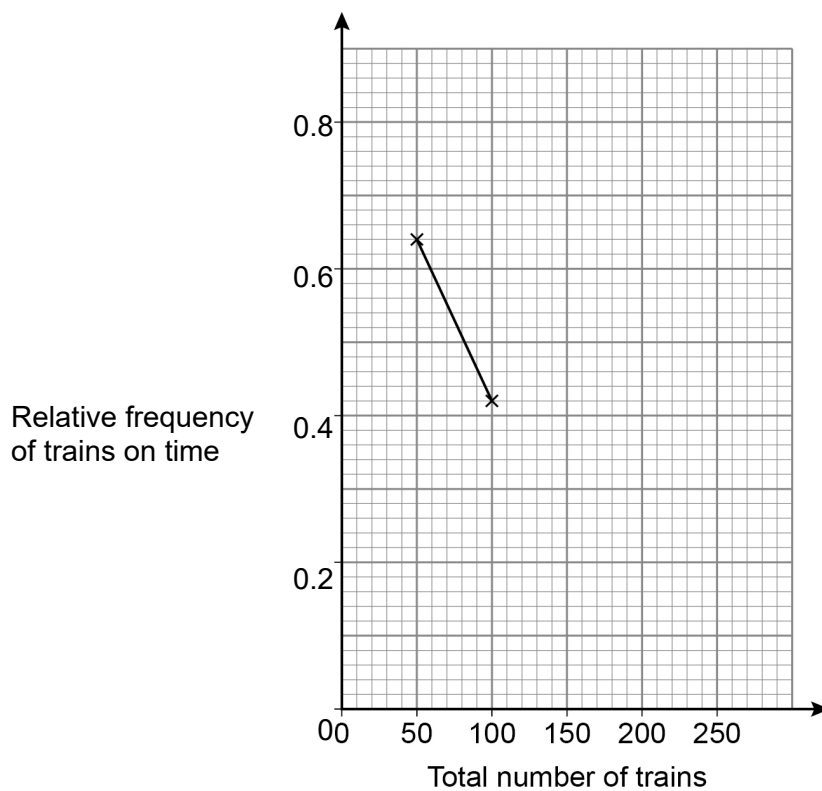
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- 11** 250 trains arrived at a station.  
The number of trains that were on time was recorded after every 50 trains.  
The table shows some information about the results.

<b>Total number of trains</b>	50	100	150	200	250
<b>Total number of trains on time</b>	32	42	108	160	185
<b>Relative frequency of trains on time</b>	0.64	0.42			

- 11 (a)** Complete the relative frequency graph.

**[3 marks]**



- 11 (b)** Write down the best estimate of the probability that a train arriving at the station is on time.

**[1 mark]**

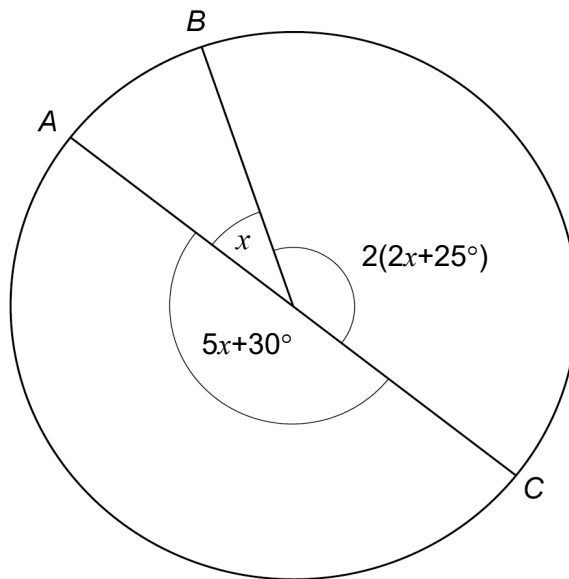
Answer \_\_\_\_\_

12

$A$ ,  $B$  and  $C$  are three points on a circle.

The radii from  $A$ ,  $B$  and  $C$  are shown.

Not drawn  
accurately



Is  $AC$  a diameter of the circle?

You **must** show your working.

[3 marks]

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13

A straight line

has gradient 5

and

passes through the point (3, 11)

Work out the equation of the line.

Give your answer in the form  $y = mx + c$ **[3 marks]**

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Answer \_\_\_\_\_

**Turn over for the next question****Turn over ►**

**14** The population of moths in a park is 5800

**14 (a)** Assume that the population increases by 15% each day.

Show that after 12 days the population would be greater than 30 000

**[2 marks]**

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**14 (b)** In fact, the population  
increases by 17% each day for 11 days  
then  
**decreases** by 9% for 1 day.

After the 12 days, is the actual population greater than 30 000 ?

Tick a box.

Yes

No

Show working to support your answer.

**[2 marks]**

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- 14 (c) The expected number of visitors to the park each day depends on the temperature.

Temperature	Expected number of visitors each day
Less than 20°C	500
20°C or more	700

On each of the 31 days in July

the park is open

the probability that the temperature is less than 20°C is 0.3

Work out the **total** number of expected visitors to the park in July.

[3 marks]

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Answer \_\_\_\_\_

- 15**  $y$  is inversely proportional to  $x^2$   
 $y = 6$  when  $x = 2$

**15 (a)** Work out an equation connecting  $y$  and  $x$ .

**[3 marks]**

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Answer \_\_\_\_\_

**15 (b)** Work out the value of  $y$  when  $x = 5$

**[2 marks]**

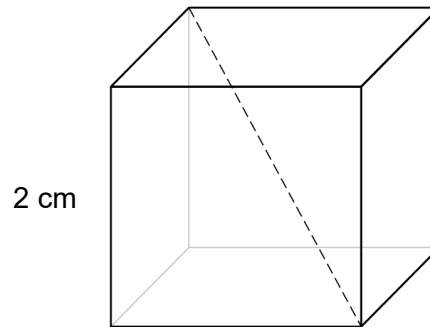
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Answer \_\_\_\_\_

- 16** Here is a cube with edge length 2 cm  
One diagonal is shown.



- 16 (a)** Circle the length, in centimetres, of the diagonal.

[1 mark]

$\sqrt{6}$	$\sqrt{8}$	$\sqrt{12}$	8
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- 16 (b)** The total length, in centimetres, of the edges of a different cube is a multiple of 24  
Circle the correct statement.

[1 mark]

The length of each side is a whole number	The length of each side is <b>not</b> a whole number	The length of each side <b>might</b> be a whole number
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**Turn over for the next question**

**Turn over ►**

- 17** 30 people were asked which public transport they used more often, bus or train.  
The table shows the results.

	Bus	Train
Male	4	10
Female	9	7

- 17 (a)** One male and one female are chosen at random.

Work out the probability that **exactly** one of them said bus.

**[3 marks]**

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Answer \_\_\_\_\_

- 17 (b)** Two males are chosen at random.

Work out the probability that they **both** said train.

**[2 marks]**

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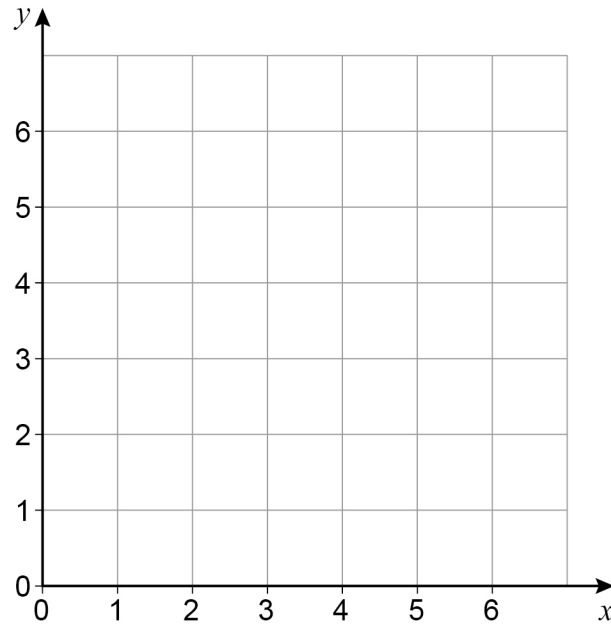
Answer \_\_\_\_\_

18 On the grid, identify the region represented by

$$x \leq 4 \quad y < 6 \quad x + y \geq 6$$

Label the region R.

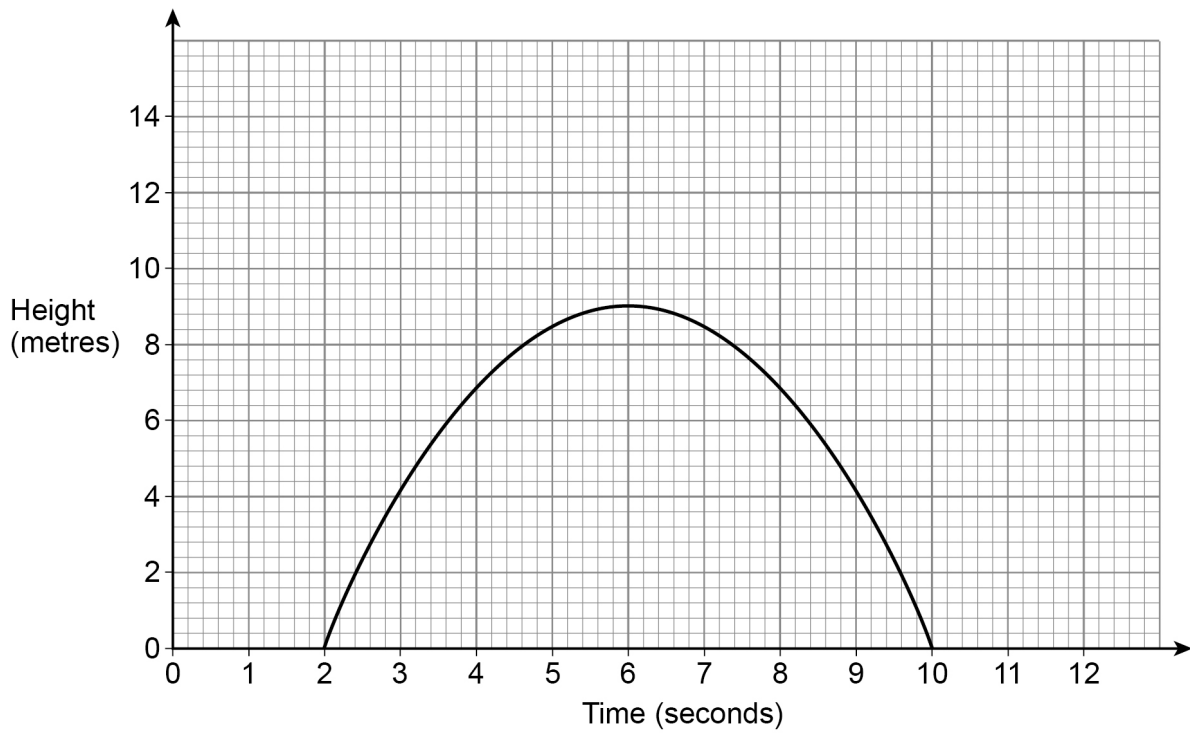
[3 marks]



Turn over for the next question

Turn over ►

- 19 The graph shows the height above ground of a toy rocket for 10 seconds.



- 19 (a) For how long is the rocket in the air?  
Circle your answer.

[1 mark]

10 seconds

8 seconds

5 seconds

2 seconds

- 19 (b)** Using the graph, estimate the speed of the rocket after 4 seconds.  
State the units of your answer.

**[3 marks]**

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Answer \_\_\_\_\_

- 20** A square has an area of 1.44 square centimetres.  
Circle the length, in **millimetres**, of one side of the square.

**[1 mark]**

1.2 mm

12 mm

120 mm

1200 mm

**Turn over for the next question**

**Turn over ►**



**22**

Maria is trying to remember a 3-digit password using the digits 1–9.

She knows the rule that

the first digit is an even number

the second digit is a factor of 18

the third digit is a square number.

Maria tries at random a password that matches the rule.

Work out the probability that this is the correct password.

**[4 marks]**

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Answer \_\_\_\_\_

8
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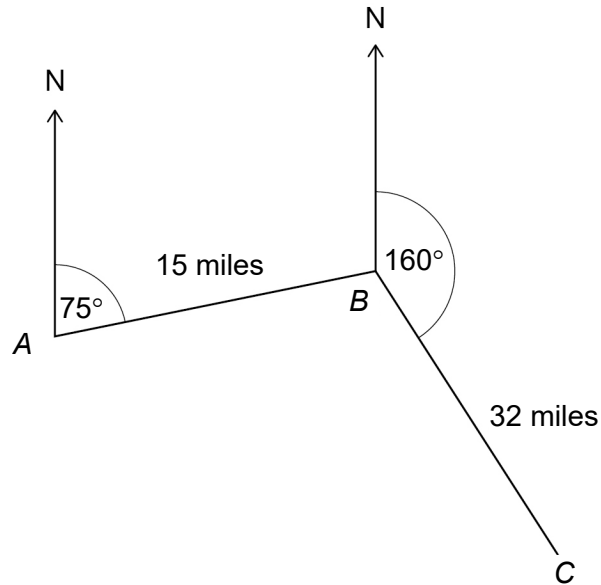
**Turn over ►**

23

A ship sails from  $A$  to  $B$  and then from  $B$  to  $C$ .

$B$  is 15 miles from  $A$ , on a bearing of  $075^\circ$

$C$  is 32 miles from  $B$ , on a bearing of  $160^\circ$



Not drawn  
accurately

Work out the direct distance from  $A$  to  $C$ .

[4 marks]

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Answer \_\_\_\_\_ miles

24

The journey of a train was in two stages.  
The table shows information about the journey.

	Distance (km)	Speed (km/h)	Time (hours)
<b>1st stage</b>	306	$x - 16$	$\frac{306}{x - 16}$
<b>2nd stage</b>	550	$x$	$\frac{550}{x}$

In total, the journey lasted 4 hours.

Work out the value of  $x$ .

**[5 marks]**

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Answer \_\_\_\_\_

25 The equation of a curve is  $y = x^2 - 12x + 32$

By completing the square, work out the coordinates of the turning point.

You **must** show your working.

[3 marks]

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

**END OF QUESTIONS**

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ANSWER IN THE SPACES PROVIDED**







Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Candidate signature \_\_\_\_\_

I declare this is my own work.

# GCSE MATHEMATICS

# H

Higher Tier

Paper 3 Calculator

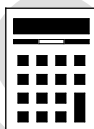
Shadow paper based on November 2021 question paper

Time allowed: 1 hour 30 minutes

## Materials

For this paper you must have:

- a calculator
- mathematical instruments.



## 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.

## Advice

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

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	
26	
<b>TOTAL</b>	

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

**1**  $b$  is 4 less than the square root of  $a$ .

Circle the correct equation.

[1 mark]

$$b = \sqrt{a} - 4$$

$$b = \sqrt{a} + 4$$

$$b = \sqrt{a-4}$$

$$b = \sqrt{a+4}$$

**2** Circle the smallest number.

[1 mark]

0.6

0.66

0.656

0.656

**3** A line has equation  $4y = 2x - 3$

Circle the coordinates of the intercept of the line with the  $y$ -axis.

[1 mark]

$(0, 2)$

$(0, -2)$

$\left(0, \frac{3}{4}\right)$

$\left(0, -\frac{3}{4}\right)$

- 4 Factorise  $y^2 - 81$   
Circle your answer.

[1 mark]

$(y + 9)^2$

$(y - 9)^2$

$(y + 9)(y - 9)$

$y(y - 81)$

- 5 Five positive numbers have  
a mean of 8  
a range of 10

Three of the numbers are 3 7 12

Work out the other two numbers.

[3 marks]

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Answer \_\_\_\_\_ and \_\_\_\_\_

- 6 At an adventure park there is a zoo, a fair and a cafe.  
The table shows the prices per person to visit the park.

	Price per person
Cafe only	Free
Zoo and fair	£27.50
Zoo only	£18
Fair only	£17

One day, 4200 people visit the adventure park.

67 visit the cafe **only**.

45% visit the zoo **and** the fair.

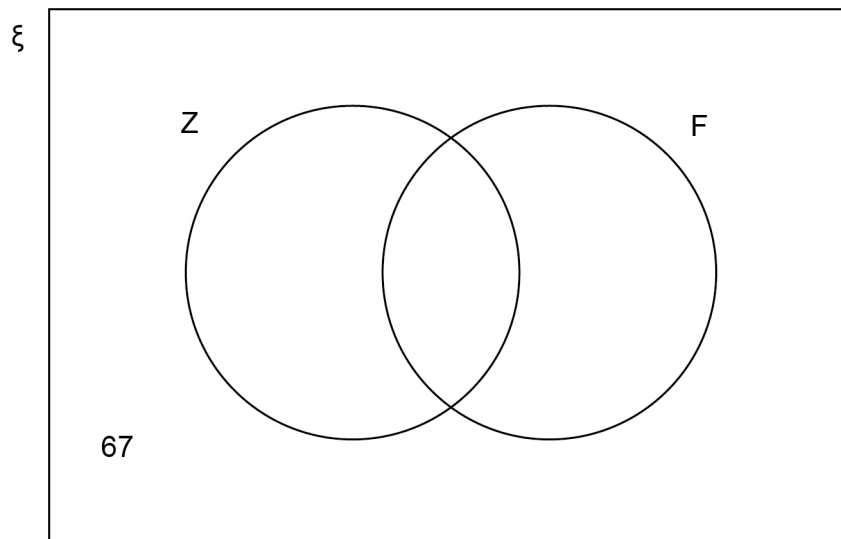
$\frac{2}{7}$  visit the zoo **only**.

The rest visit the fair **only**.

In total, how much do the 4200 people pay to visit the adventure park?

You may use the Venn diagram to help you.

[5 marks]





8 A widget compressor exerts a pressure of 258 pounds per square inch.

Convert this pressure into kilograms per square centimetre.

Use

1 pound = 0.45 kilograms

1 square inch = 6.25 square centimetres

**[3 marks]**

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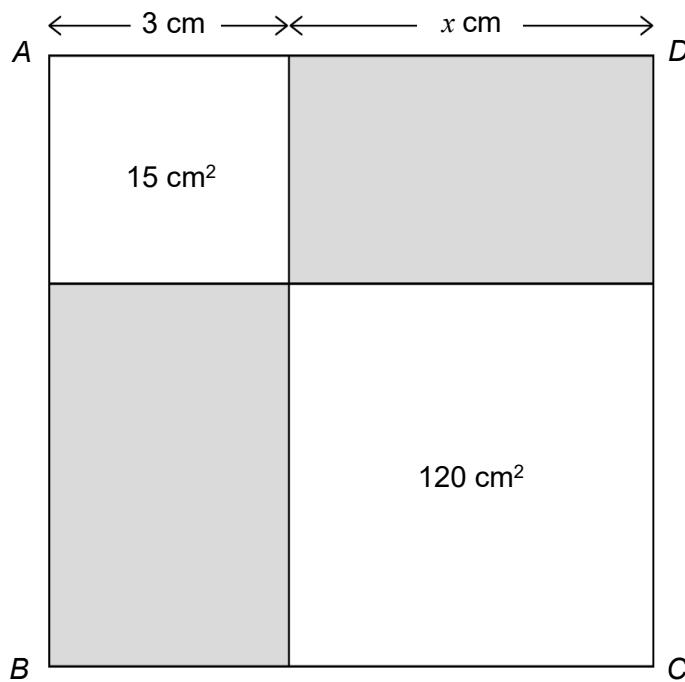
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Answer \_\_\_\_\_ kg/cm<sup>2</sup>

- 9 Square  $ABCD$  is split into four smaller rectangles.  
Two of the smaller rectangles are shaded.



Not drawn  
accurately

$$3 : x = 1 : 4$$

For square  $ABCD$ , work out the ratio shaded area : unshaded area  
Give your answer in its simplest form.

[4 marks]

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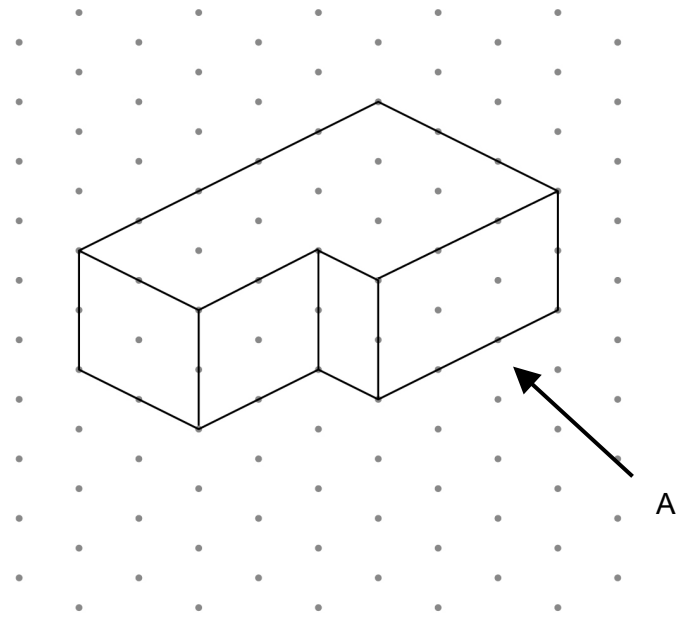


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Answer \_\_\_\_\_ : \_\_\_\_\_

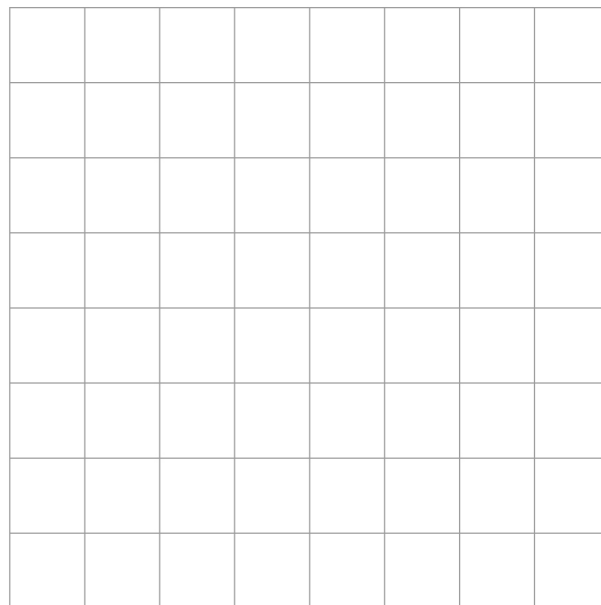
Turn over ►

- 10** A solid shape is drawn on isometric paper.



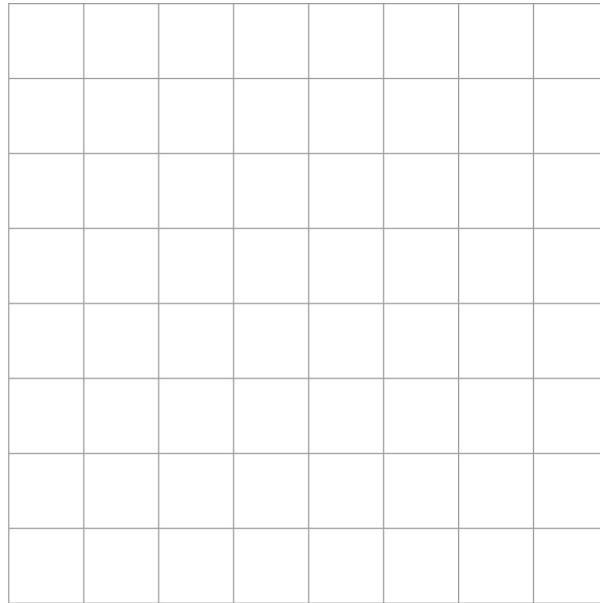
- 10 (a)** On the centimetre grid, draw the elevation of the shape from A.

**[1 mark]**



10 (b) On the centimetre grid, draw a plan of the shape.

[1 mark]



11 Eloise thinks of a prime number between 30 and 40

Her number is  $x\%$  of 121

Work out **one** possible value of  $x$ .

[3 marks]

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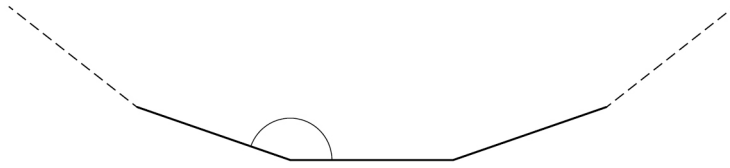
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Answer \_\_\_\_\_

- 12 Part of a regular polygon with 20 sides is shown.

Not drawn  
accurately



Work out the size of an **interior** angle.

[2 marks]

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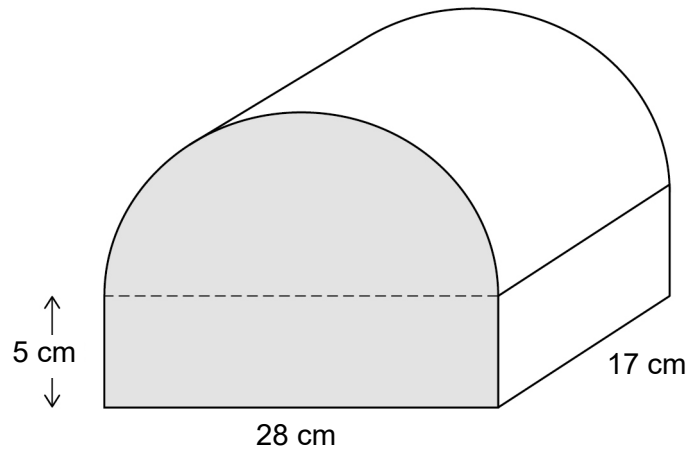
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Answer \_\_\_\_\_ degrees

- 13 A box is the shape of half a cylinder on top of a cuboid.



Work out the volume of the box.

[4 marks]

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Answer \_\_\_\_\_  $\text{cm}^3$

14

James sells bathroom tiles.

He increases the original price of each tile by 15% to £13.80

A month later he announces a sale.



James says,

“The tiles will be back to their original price, because each change was by 15%”

Is he correct?

Tick a box.

Yes

No

Show working to support your answer.

**[3 marks]**

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17  $\frac{m^2}{2} > 18$

Circle the possible value of  $m$ .

[1 mark]

$$-5\frac{7}{8}$$

5.8

6

$$-\frac{13}{2}$$

18 Simplify  $x^2 \times w^0$

Circle your answer.

[1 mark]

$$x^2w$$

$$w^2$$

$$xw$$

$$x^2$$

19 The equation of a circle is  $x^2 + y^2 = 17$

Work out the length of the **diameter**.

Circle your answer.

[1 mark]

$$\sqrt{17}$$

$$2\sqrt{17}$$

$$\sqrt{34}$$

$$34$$

Turn over for the next question

Turn over ►

20

$$\frac{a}{b} = 5c$$

$$\frac{b}{c} = 3$$

Work out the value of  $a$  when  $c = 6$

**[3 marks]**

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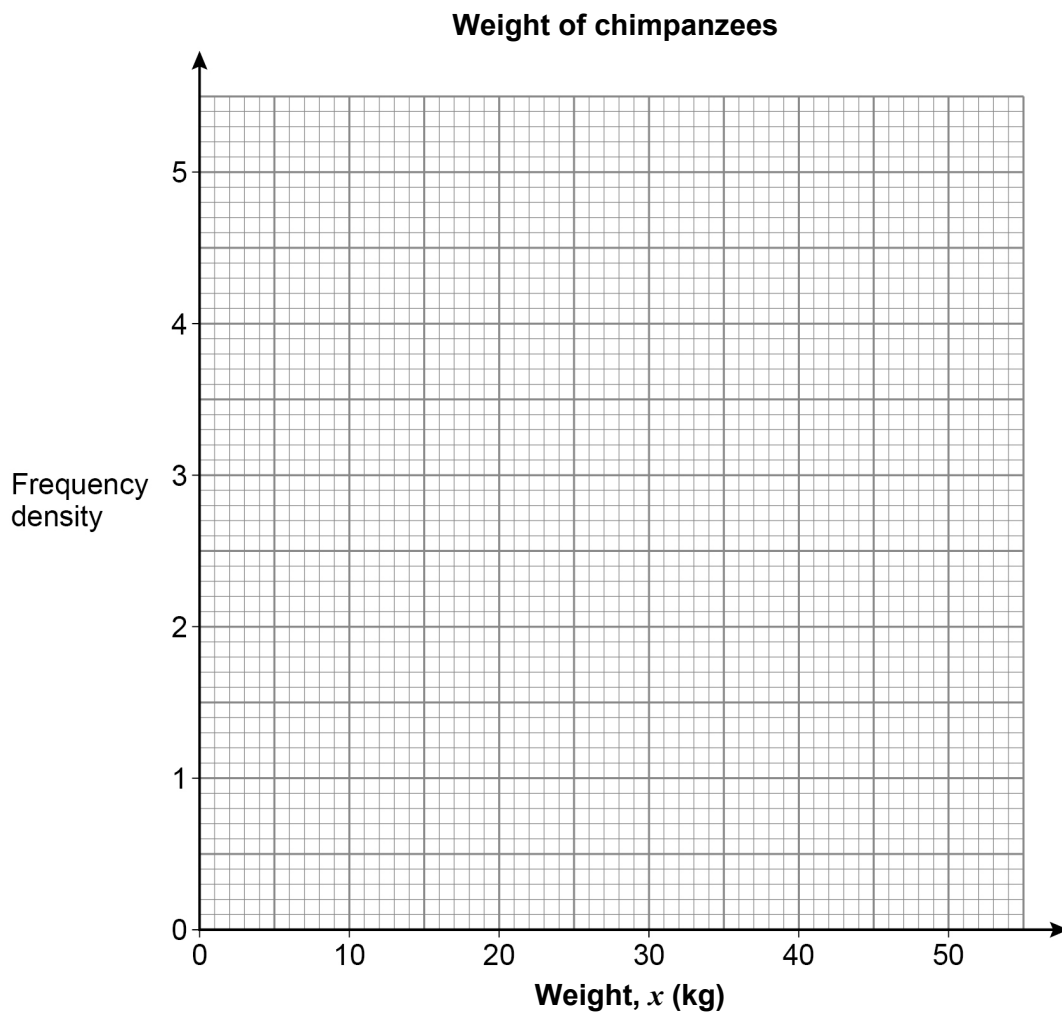
Answer \_\_\_\_\_

21

Here is some information about the weights of chimpanzees in a forest.

Weight, $x$ (kg)	Frequency		
$0 \leq x < 20$	20		
$20 \leq x < 25$	23		
$25 \leq x < 35$	27		
$35 \leq x < 50$	33		

Draw a histogram to represent the information.

**[4 marks]****Turn over ►**

22

A sequence of patterns is made using horizontal sticks and vertical sticks.

Pattern 1



Pattern 2



Pattern 3



The table shows the number of horizontal sticks and vertical sticks in each pattern.

Pattern	Number of horizontal sticks	Number of vertical sticks
1	2	2
2	4	3
3	6	4

What fraction of the total number of sticks in Pattern  $n$  are vertical?

Give your answer in terms of  $n$ .

**[3 marks]**

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Answer \_\_\_\_\_

**23** The equation of a curve is  $y = 3^{2x}$

**23 (a)** Circle the point that lies on the curve.

[1 mark]

(2, 27)

(27, 2)

(2, 81)

(81, 2)

**23 (b)** A different point on the curve has  $y$ -coordinate  $\frac{1}{3}$

Work out the  $x$ -coordinate.

[1 mark]

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Answer \_\_\_\_\_

**24**  $a^b = 5$  where  $a$  is an integer and  $b$  is a proper fraction.

Work out **one** possible pair of values of  $a$  and  $b$ .

[1 mark]

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$a =$  \_\_\_\_\_  $b =$  \_\_\_\_\_

25 Expand and simplify fully  $(2x + 2)(x - 3)(x - 4)$  [3 marks]

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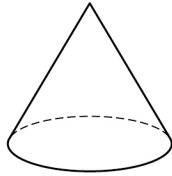
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Answer \_\_\_\_\_

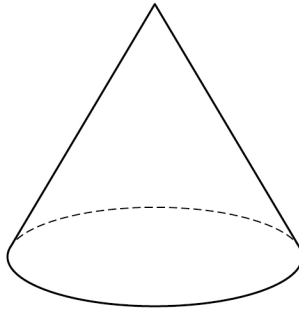
26

Here are two similar cones.

Cone A



Cone B

The surface area of cone A is  $5 \text{ m}^2$ The surface area of cone B is  $7.2 \text{ m}^2$ 

Work out the ratio radius of cone A : radius of cone B

Give your answer in the form  $1 : n$ **[3 marks]**


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

27

In the diagram

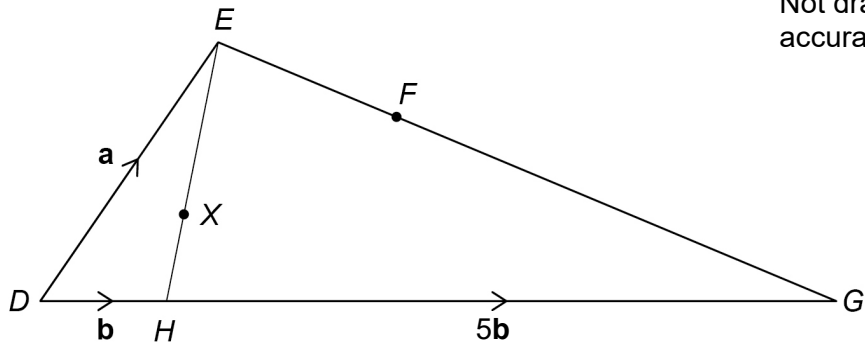
$$\overrightarrow{DE} = \mathbf{a}$$

$$\overrightarrow{DH} = \mathbf{b}$$

$$\overrightarrow{HG} = 5\mathbf{b}$$

$$EX : XH = 3 : 2$$

$$EF : FG = 1 : 4$$



27 (a) Show that  $\overrightarrow{DX} = \frac{2}{5}\mathbf{a} + \frac{3}{5}\mathbf{b}$

[2 marks]

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**27 (b)** Is *DXF* a straight line?  
Show working to support your answer.

**[4 marks]**

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**Turn over for the next question**

**6**

**Turn over ►**

28  $a = 5.83$  to 3 significant figures.

$b = 116$  to 3 significant figures.

Work out the lower bound of  $\frac{a}{b}$

You **must** show your working.

[3 marks]

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Answer \_\_\_\_\_

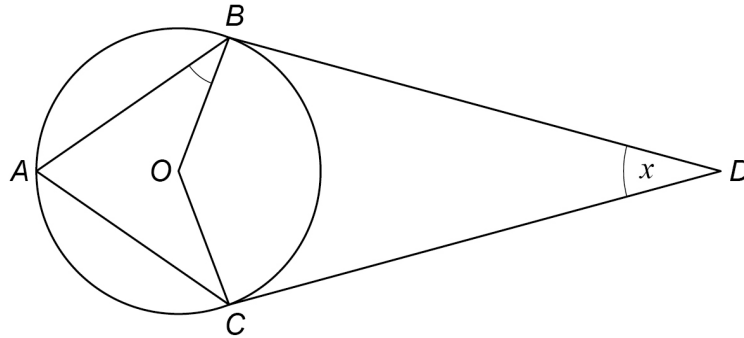
29

$A$ ,  $B$  and  $C$  are three points on the circumference of a circle, centre  $O$ .

$BD$  and  $CD$  are tangents to the circle.

$ABDC$  is a kite.

Angle  $BDC$  is  $x$



Not drawn  
accurately

Find an expression for the size of angle  $ABO$ . Give a reason for each stage of your working.

[4 marks]

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Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

Candidate signature \_\_\_\_\_

I declare this is my own work.

# GCSE MATHEMATICS

# H

Higher Tier

Paper 1 Non-Calculator

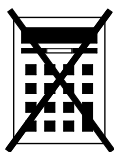
Shadow paper based on June 2023 question paper

Time allowed: 1 hour 30 minutes

## Materials

For this paper you must have:

- mathematical instruments



You must **not** use a calculator.

## 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.

## Advice

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

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	
<b>TOTAL</b>	

Answer **all** questions in the spaces provided.1 (a) Work out  $0.3 \times 0.2$ **[1 mark]**

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Answer \_\_\_\_\_

1 (b) Work out  $\frac{4}{5} \div 7$ **[1 mark]**

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Answer \_\_\_\_\_

1 (c) Work out  $16 \div 0.2$ **[1 mark]**

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Answer \_\_\_\_\_

2 Solve  $5x < 60$ **[1 mark]**

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Answer \_\_\_\_\_

3 Work out the value of  $\left(\frac{5}{3}\right)^2$

Give your answer as a mixed number.

[1 mark]

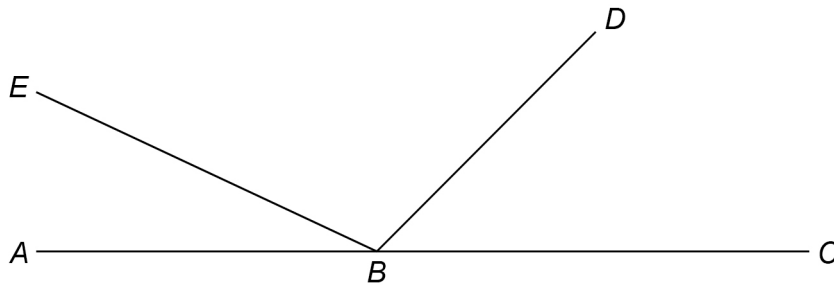
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Answer \_\_\_\_\_

4  $ABC$ ,  $BD$  and  $BE$  are straight lines.



Not drawn  
accurately

angle  $EBD = 6 \times$  angle  $ABE$

angle  $DBC = 3 \times$  angle  $ABE$

Work out the size of angle  $DBC$ .

[3 marks]

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Answer \_\_\_\_\_°

- 5** Two prime numbers are multiplied together.  
The answer is an **even** number between 40 and 50  
Complete the calculation.

**[3 marks]**

$$\square \times \square = \square$$

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- 6** Chloe and Mikey share some money in the ratio 3 : 4  
Mikey gets £72

Chloe gives  $\frac{1}{6}$  of her share to Pippa.

Mikey gives  $\frac{4}{9}$  of his share to Pippa.

How much money does Pippa receive?

**[4 marks]**

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Answer £ \_\_\_\_\_

7  $2^a \times 3^2 \times 5 = 360$

Work out the value of  $a$ .

You **must** show your working.

[3 marks]

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$a =$  \_\_\_\_\_

8 Expand and simplify fully  $2(5x + 6) - 3(x - 2)$

[2 marks]

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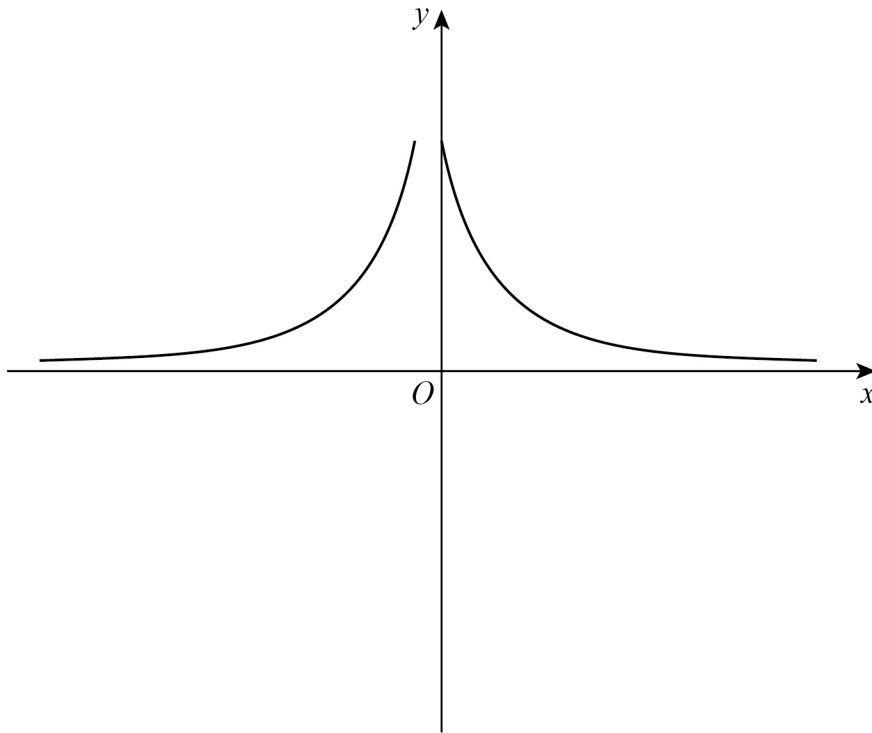
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Answer \_\_\_\_\_

**Turn over for the next question**

- 9 Erika tries to sketch the graph  $y = \frac{1}{x}$  with  $x \neq 0$



Make **two** different criticisms of her sketch.

**[2 marks]**

Criticism 1 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Criticism 2 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

- 10** Wenjie is  $x$  years old.  
Megan is five years older than Wenjie.  
Conor is three times as old as Wenjie.
- The mean of their ages is 35.
- How old is **Conor**? **[5 marks]**

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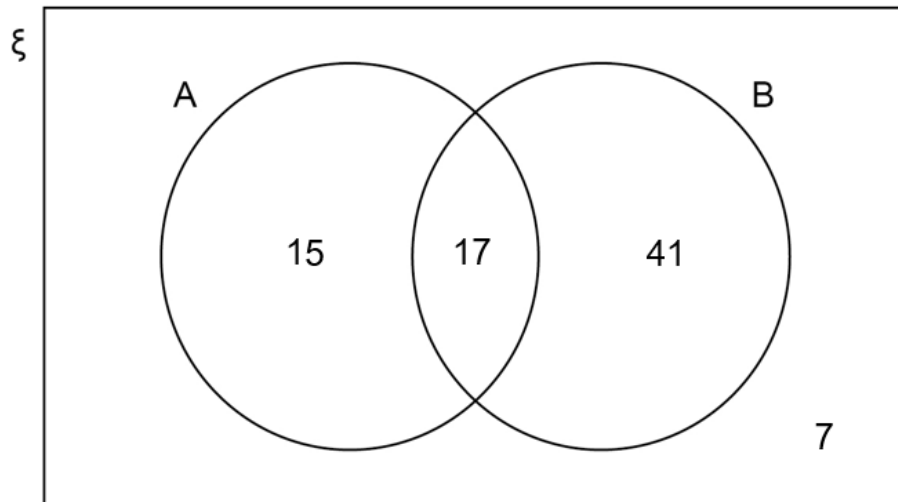
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Answer \_\_\_\_\_

**Turn over for the next question**

- 11 The Venn diagram represents 80 items.



- 11 (a) Write down  $P(B)$

[1 mark]

Answer \_\_\_\_\_

- 11 (b) Work out  $P(A \cup B)$

[1 mark]

\_\_\_\_\_

\_\_\_\_\_

Answer \_\_\_\_\_

- 11 (c) Work out  $P(A' \cap B)$

[1 mark]

\_\_\_\_\_

\_\_\_\_\_

Answer \_\_\_\_\_

**12 (a)**  $a \times 10^n$  is a number in standard form.

Complete the inequality for the value of  $a$ .

[1 mark]

\_\_\_\_\_  $\leq a <$  \_\_\_\_\_

**12 (b)**  $b \times 10^n$  is the number 45 000 written in standard form.

Work out  $b \times 10^{-n}$

Write your answer as an ordinary number.

[2 marks]

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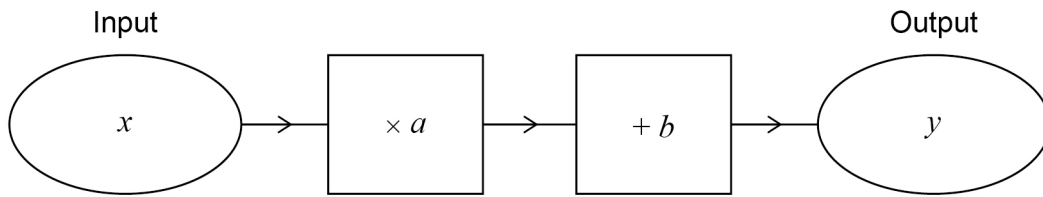
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Answer \_\_\_\_\_

**Turn over for the next question**

**13 (a)** Here is a number machine.



Show that when the input decreases by 3 the output decreases by  $3a$ .

**[2 marks]**

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**13 (b)**  $f(x) = kx^3$  where  $k$  is a constant.

Josh says that  $f(2) \times f(1)$  is equal to  $f(2)$  because  $2 \times 1 = 2$

Is he correct?

Show working to support your answer.

**[2 marks]**

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14

Here is a list of 11 whole numbers in numerical order.

The lower quartile, median, upper quartile and highest value are missing.

1	3		9	13		23	32		44	
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- median =  $3.5 \times$  lower quartile
- upper quartile =  $6 \times$  lower quartile
- range =  $1.5 \times$  interquartile range

Complete the list.

**[2 marks]**

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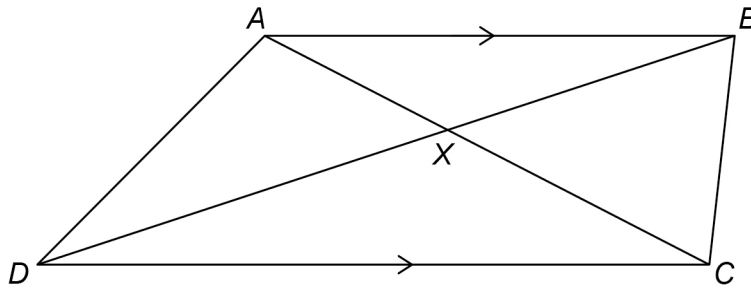
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**Turn over for the next question**

15

 $ABCD$  is a trapezium.

All four sides are different lengths.

 $AB$  is parallel to  $CD$ .The diagonals intersect at  $X$ .Not drawn  
accurately

For each statement, tick the correct box.

[4 marks]

	True	May be true	Not true
Triangles $AXD$ and $BCX$ are similar	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Triangles $ABX$ and $CDX$ are congruent	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Angle $BAC =$ angle $ACD$	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Area of triangle $BCD =$ area of triangle $ACD$	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>





18

$$4 < \sqrt[3]{x} < 5$$

Circle the possible value of  $x$ .

[1 mark]

1.4

64

102

500

19

Work out how many 5-digit **even** numbers can be made using these digits **once** each.

2

4

6

7

9

Do **not** list them.

[2 marks]

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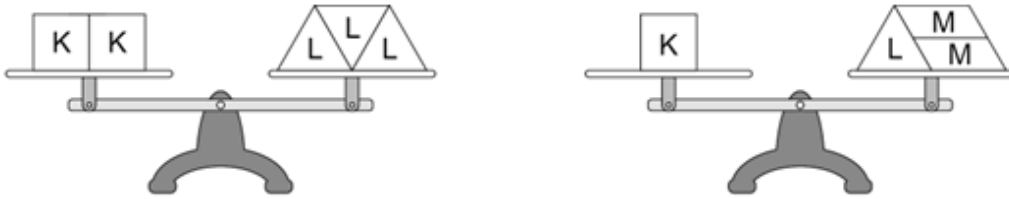
Answer \_\_\_\_\_

**Turn over for the next question**

20

K, L and M are weights.

Both of the scales balance exactly.

How many M weights are needed to balance **one** L weight?**[3 marks]**


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Answer \_\_\_\_\_

21 Express  $x^2 - 8x + 9$  in the form  $(x - a)^2 - b$  where  $a$  and  $b$  are integers.

[2 marks]

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Answer \_\_\_\_\_

22  $a = \sqrt{3}$  and  $b = \sqrt{12}$

Match each expression to its value.

One has been done for you.

[3 marks]

$a^2$	3
$a + b$	2
$ab$	6
$\frac{b}{a}$	$3\sqrt{3}$
	36
	$10\sqrt{20}$

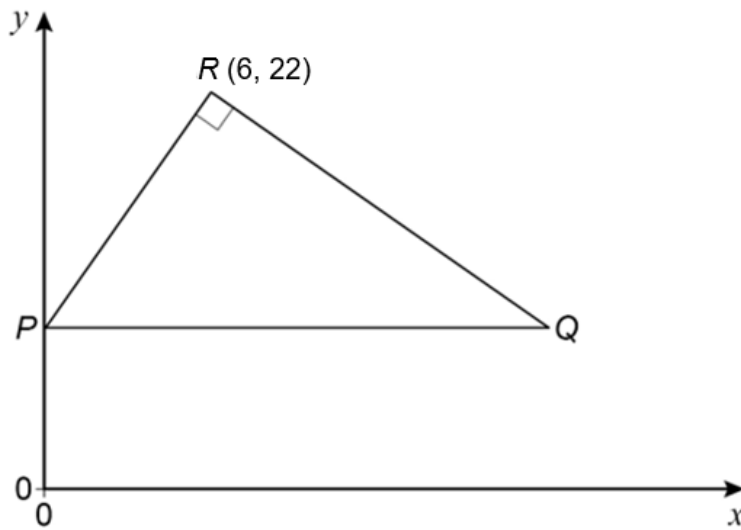
Turn over for the next question

8

Turn over ►



24 Points  $P$ ,  $Q$  and  $R(6, 22)$  form a triangle.



Not drawn  
accurately

$PQ$  is a horizontal line, with  $P$  on the  $y$ -axis.

Angle  $PRQ$  is a right angle.

The gradient of  $PR$  is 3

Work out the coordinates of  $Q$ .

[5 marks]

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

8

Turn over ►

**25** Show that  $\frac{5\sin 60^\circ - \cos 30^\circ}{2\tan 60^\circ}$  can be written as  $\tan x$ , where  $x$  is an acute angle.

**[4 marks]**

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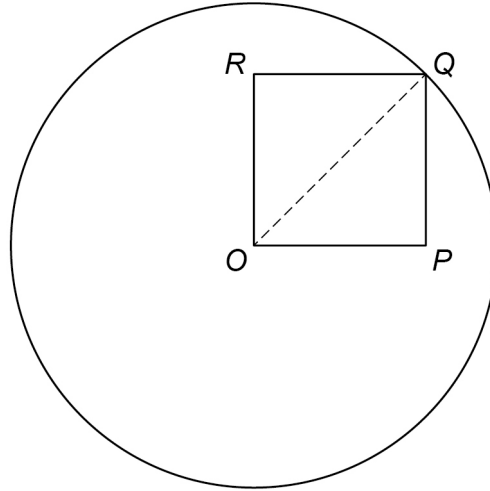
26

A circle, centre  $O$ , has an area of  $36\pi$  cm

$Q$  is a point on the circle.

$OPQR$  is a **square**.

Not drawn  
accurately



area of the square : area of the circle =  $\frac{1}{a} : \pi$  where  $a$  is an integer.

Work out the value of  $a$ .

You **must** show your working.

[4 marks]

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$a =$  \_\_\_\_\_

Turn over ►

27

Liquid C is made by mixing liquid A and liquid B.

	Mass (g)	Density (g/cm <sup>3</sup> )	Volume (cm <sup>3</sup> )
<b>Liquid A</b>	200	$a$	$\frac{200}{a}$
<b>Liquid B</b>	300	$b$	$\frac{300}{b}$

Show that the density of liquid C, in g/cm<sup>3</sup>, is  $\frac{5ab}{3a+2b}$

**[3 marks]**


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**END OF QUESTIONS****Copyright information**

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# GCSE MATHEMATICS 8300/2H

Higher Tier

Paper 2 Calculator

Shadow paper based on June 2023 paper

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**Mark scheme**

June 2023

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Version: 1.0

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [aqa.org.uk](http://aqa.org.uk)

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## Glossary for Mark Schemes

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

<b>M</b>	Method marks are awarded for a correct method which could lead to a correct answer.
<b>A</b>	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
<b>B</b>	Marks awarded independent of method.
<b>ft</b>	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
<b>SC</b>	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
<b>M dep</b>	A method mark dependent on a previous method mark being awarded.
<b>B dep</b>	A mark that can only be awarded if a previous independent mark has been awarded.
<b>oe</b>	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
<b>[a, b]</b>	Accept values between a and b inclusive.
<b>[a, b)</b>	Accept values $a \leq \text{value} < b$
<b>3.14 ...</b>	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
<b>Use of brackets</b>	It is not necessary to see the bracketed work to award the marks.

Examiners should consistently apply the following principles.

### **Diagrams**

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

### **Responses which appear to come from incorrect methods**

Whenever there is doubt as to whether a student has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the student. In cases where there is no doubt that the answer has come from incorrect working then the student should be penalised.

### **Questions which ask students to show working**

Instructions on marking will be given but usually marks are not awarded to students who show no working.

### **Questions which do not ask students to show working**

As a general principle, a correct response is awarded full marks.

### **Misread or miscopy**

Students often copy values from a question incorrectly. If the examiner thinks that the student has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

### **Further work**

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

### **Choice**

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

### **Work not replaced**

Erased or crossed out work that is still legible should be marked.

### **Work replaced**

Erased or crossed out work that has been replaced is not awarded marks.

### **Premature approximation**

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

### **Continental notation**

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the student intended it to be a decimal point.

Q	Answer	Mark	Comments
1	$\frac{28}{8}$ or 3.5	B1	oe fraction, mixed number or decimal eg $\frac{7}{2}$ or $3\frac{1}{2}$
	<b>Additional Guidance</b>		
	Ignore simplification or conversion attempt after correct answer seen eg $\frac{28}{8}$ in working with 3.6 on answer line		B1
	28 ÷ 8 with no further correct work		B0

Q	Answer	Mark	Comments
2	21	B1	

Q	Answer	Mark	Comments
3	$\frac{8}{5}$ or 1.6	B1	oe fraction, mixed number or decimal eg $1\frac{3}{5}$
	<b>Additional Guidance</b>		
	Ignore conversion attempt after correct answer seen eg $\frac{8}{5} = 1.7$		B1
	Condone answer $\frac{1}{\frac{5}{8}}$		B1
	Condone answer $\left(\frac{5}{8}\right)^{-1}$ (without brackets B0)		B1
	Do not allow $1 \div \frac{5}{8}$		B0
	$\frac{-8}{-5}$		B1

Q	Answer	Mark	Comments	
4	137.5% or 1.375 or $\frac{11}{8}$ or $38.17 \div 137.5 (\times 100)$ or $0.2776 (\times 100)$	M1	oe eg $1 + 0.375$ or $38.17 \div 11 \times 8$ or $3.47 \times 8$	
	27.76	A1		
	<b>Additional Guidance</b>			
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts			
	M1 may be seen in a trial (the answer to the trial can be ignored) eg $30 \times 1.375$			M1
	$38.17 \times 1.375$			M1
	Do not allow misreads for 37.5% eg1 $38.17 \div 1.0375$ eg2 $38.17 \div 137$			M0 M0
137.5 not recovered			M0	

Q	Answer	Mark	Comments												
5	$35 \times 9$ or 315	M1	oe number of 2p coins may be embedded												
	$35 \times 9 \times 2$ or $315 \times 2$ or 630 or 6.3(0)	M1dep	oe value of 2p coins implied by 980 or 9.8(0)												
	14.3(0) – their 6.3(0) – $35 \times 0.1(0)$ or 1430 – their 630 – $35 \times 10$ or 4.5(0) or 450	M1dep	oe value of 5p coins implied by 6.3 : 4.5 oe ratio not in simplest form or 4.5 : 6.3 oe ratio												
	7 : 5	A1	accept 1.4 : 1 or $\frac{7}{5} : 1$ or $1\frac{2}{5} : 1$ or 1 : 0.71(...) or $1 : \frac{5}{7}$												
	<b>Additional Guidance</b>														
	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts														
	Allow working in pence or pounds throughout														
	Must work consistently in pence or pounds for the third mark (or recover)														
	Ignore units in the ratio eg 7p : 5p or £1.40 : £1			M3A1											
	630 may be seen in a ratio with the value of the 10p coins eg 630 : 350 or 6.3 : 3.5			M2											
450 may be seen in a ratio with the value of the 10p coins eg 450 : 350 or 4.5 : 3.5			M3												
For information:															
<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Coin</th> <th>10p</th> <th>2p</th> <th>5p</th> </tr> </thead> <tbody> <tr> <td>Number</td> <td>35</td> <td>315</td> <td>90</td> </tr> <tr> <td>Value</td> <td>£3.50</td> <td>£6.30</td> <td>£4.50</td> </tr> </tbody> </table>				Coin	10p	2p	5p	Number	35	315	90	Value	£3.50	£6.30	£4.50
Coin	10p	2p	5p												
Number	35	315	90												
Value	£3.50	£6.30	£4.50												

Q	Answer	Mark	Comments
6(a)	360 ÷ 6 or 120 seen	M1	oe eg 60 × 6 = 360 or 180 – $\frac{(6-2) \times 180}{6}$ may be on diagram
	60	A1	
	<b>Additional Guidance</b>		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	60 seen but not chosen as answer, even if linked to the wrong angle		M1A0

Q	Answer	Mark	Comments
6(b)	It is less than the answer to part (a)	B1	

Q	Answer	Mark	Comments																											
7(a)	All values correct	B2	B1 1 or 2 rows correct																											
	<b>Additional Guidance</b>																													
	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> </tr> </thead> <tbody> <tr> <th>5x</th> <td>5</td> <td>10</td> <td>15</td> <td>20</td> <td>25</td> <td>30</td> </tr> <tr> <th>8x</th> <td>8</td> <td>16</td> <td>24</td> <td>32</td> <td>40</td> <td>48</td> </tr> <tr> <th>x<sup>2</sup></th> <td>1</td> <td>4</td> <td>9</td> <td>16</td> <td>25</td> <td>36</td> </tr> </tbody> </table>			1	2	3	4	5	6	5x	5	10	15	20	25	30	8x	8	16	24	32	40	48	x <sup>2</sup>	1	4	9	16	25	36
	1	2	3	4	5	6																								
5x	5	10	15	20	25	30																								
8x	8	16	24	32	40	48																								
x <sup>2</sup>	1	4	9	16	25	36																								

Q	Answer	Mark	Comments
7(b)	$\frac{5}{18}$ or 0.27(7...) or 0.28 or 27(.7...) % or 28%	B1ft	oe fraction, decimal or percentage ft their table with $\geq 12$ values must be using 18 for the total number of possible scores
	<b>Additional Guidance</b>		
	Ignore simplification or conversion attempt (not ratio) after correct probability seen		
	Ratio answer eg 5 : 18, even alongside a correct probability is B0		
	ft decimals or percentages must be correct to the same accuracy as in the scheme eg 8 winning values in their table $\frac{8}{18}$ or 0.44(4...) or 44(.4...) %	B1ft	

Q	Answer	Mark	Comments	
7(c)	$756 \times \text{their } \frac{5}{18}$	M1	oe ft their probability from (b) or if no probability in (b), ft their table with $\geq 12$ values where $0 < \text{their probability} < 1$ probabilities, if rounded in (c), must be truncated or rounded to at least 2 sf	
	210	A1		
	<b>Additional Guidance</b>			
	Answer 210	M1A1	$\frac{210}{756}$ on answer line	M1A0
	Condone 210 out of 756	M1A1	Do not treat estimating by rounding as a misread eg1 800 used instead of 756 eg2 (b) 0.27      (c) $0.3 \times 756$ (rounded to 1sf in (c) for the probability) eg3 (b) 0.3      (c) $0.3 \times 756$ (follows through their (b))	M0A0 M0A0 M1A0
	Do not allow ft for a ratio from (b) but may ft their (a) instead		For $0.27 \times 756$ , accept $27\% \times 756$ but do not accept 27% of 756 unless recovered	
	The method mark may be implied by a ft answer (decimal or truncated to the nearest integer or rounded up to the nearest integer) eg1 (b) $\frac{6}{16}$ (c) 283.5 or 283 or 284 (correct ft method implied using (b)) eg2 (a) completed table has 6 winning values      (b) no probability shown (c) 252 (correct ft method implied using (a))	M1A0  M1A0		

Q	Answer	Mark	Comments	
8	$a = 8$ and $b = 5$	B2	B1 $a - 5 = 3$ or $a = 3 + 5$ or $a = 8$ or $4b = 20$ or $b = 20 \div 4$ or $b = 5$ SC1 $a = 5$ and $b = 8$	
	<b>Additional Guidance</b>			
	Ignore working if B2 or B1 or SC1 seen			
	$(a - 5)x^2 = 3x^2$ with no further correct work			B0
	For B1 do not allow embedded values eg $4 \times 5 = 20$			B0

Q	Answer	Mark	Comments
9	Identifies (6, 2) or (3, 8) or (–4, 2) or (–7, 8)	M1	may be seen on the grid mark intention on diagram eg parallelogram drawn with one of the vertices at (6, 2) or (6, 2) plotted
	Identifies (6, 2) and (3, 8) <b>or</b> identifies (–4, 2) and (–7, 8)	M1dep	may be seen on the grid mark intention on diagram eg parallelogram drawn with two of the vertices at (6, 2) and (3, 8) <b>or</b> (6, 2) and (3, 8) plotted
	Both diagonals drawn for one of the correct parallelograms or centre of one of the correct parallelograms identified or (2, 5) or (–3, 5)	M1dep	mark intention on diagram M3 may be implied eg $\left(\frac{1+3}{2}, \frac{8+2}{2}\right)$ or $\left(\frac{-4-2}{2}, \frac{8+2}{2}\right)$
	(2, 5) and (–3, 5)	A1	
	<b>Additional Guidance</b>		
	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Both answers correct (ignore working)		M3A1
	One answer correct (ignore working)		M3A0
	For first 2 marks condone correct points plotted even if labelled incorrectly		
Up to M2 can be awarded for coordinates given as answers			
Arc centre A radius 5 cm passing through (6, 2) and/or (–4, 2) is not sufficient to award M1 etc			

Q	Answer	Mark	Comments
<b>10</b>	$\begin{pmatrix} 5 \\ -4 \end{pmatrix}$	B2	B1 $\begin{pmatrix} 5 \\ \dots \end{pmatrix}$ or $\begin{pmatrix} \dots \\ -4 \end{pmatrix}$ SC1 $\begin{pmatrix} -5 \\ 4 \end{pmatrix}$
	<b>Additional Guidance</b>		
	$(5, -4)$ or $\begin{pmatrix} -4 \\ 5 \end{pmatrix}$	B0	
	Ignore words if a vector is also seen eg1 Reflection $\begin{pmatrix} 5 \\ -4 \end{pmatrix}$ eg2 5 right 4 up and $\begin{pmatrix} 5 \\ 4 \end{pmatrix}$ eg3 5 right 4 down eg4 Rotate 5 left and 4 up and $\begin{pmatrix} -5 \\ 4 \end{pmatrix}$	B2 B1 B0 SC1	
	Condone any type of brackets		
	Condone missing brackets for B2 or B1 or SC1 but must have two numbers in a column		
	Condone 'fraction line' for B2 or B1 or SC1 but must have two numbers in a column		
	$\begin{pmatrix} 5x \\ -4y \end{pmatrix}$ or $\begin{pmatrix} x5 \\ -y4 \end{pmatrix}$ or $\begin{pmatrix} x+5 \\ y-4 \end{pmatrix}$ or $\begin{pmatrix} 5 \text{ right} \\ 4 \text{ down} \end{pmatrix}$ or $\begin{pmatrix} 5 \text{ r} \\ 4 \text{ d} \end{pmatrix}$ or $\begin{pmatrix} 5 \rightarrow \\ 4 \downarrow \end{pmatrix}$	B0	

Q	Answer	Mark	Comments
<b>11</b>	<b>Alternative method 1</b> Compares 80% of volume of hemisphere with volume of water		
	$\frac{4}{3} \times \pi \times 9^3$ or $972\pi$ or [3044, 3054] or $\frac{2}{3} \times \pi \times 9^3$ or $486\pi$ or [1522, 1527]	M1	oe eg $\frac{4}{3} \pi \times 729$  allow without any multiplication signs eg $\frac{4}{3} \pi 9^3$
	$0.8 \times$ their $486\pi$ or $388.8\pi$ or [1217, 1222]	M1dep	oe $0.8 \times$ their [1522, 1527] or $\frac{1944}{5} \pi$  must be using volume of hemisphere
	$185 \times 7$ or 1295	M1	oe
	[1217, 1222] and 1295 and Yes	A1	oe
	<b>Alternative method 2</b> Works out volume of water as proportion of volume of hemisphere		
	$\frac{4}{3} \times \pi \times 9^3$ or $972\pi$ or [3044, 3054] or $\frac{2}{3} \times \pi \times 9^3$ or $486\pi$ or [1522, 1527]	M1	oe eg $\frac{4}{3} \pi \times 729$  allow without any multiplication signs eg $\frac{4}{3} \pi 9^3$
	$185 \times 7$ or 1295	M1	Oe
	their $1295 \div$ their $486\pi$ or [0.84, 0.86]	M1dep	oe eg their $1295 \div$ their [1522, 1527] or 85% dep on M2 must be using volume of hemisphere
	[84, 86](%) and Yes	A1	oe eg 0.85 and 0.8 and Yes

**Question 11 continues on the next page**

<b>11 cont</b>	<b>Alternative method 3</b> Works out time to fill 80% of volume of hemisphere		
	$\frac{4}{3} \times \pi \times 9^3$ or $972\pi$ or [3044, 3054] or $\frac{2}{3} \times \pi \times 9^3$ or $486\pi$ or [1522, 1527]	M1	oe eg $\frac{4}{3} \pi \times 729$  allow without any multiplication signs eg $\frac{4}{3} \pi 9^3$
	$0.8 \times$ their $486\pi$ or $388.8\pi$ or [1217, 1222] or their $486\pi \div 185$ or [8.1, 8.3]	M1dep	oe $0.8 \times$ their [1522, 1527] or $\frac{1944}{5}\pi$ or their [1522, 1527] $\div 185$ must be using volume of hemisphere
	$0.8 \times$ their $486\pi \div 185$ or $0.8 \times$ their [1522, 1527] $\div 185$ or [6.5, 6.61]	M1dep	oe their [1217, 1222] $\div 185$ or $0.8 \times$ their [8.1, 8.3]
	[6.5, 6.61] and Yes	A1	oe

**Question 11 continues on the next page**

<b>Additional Guidance</b>		
<b>11 cont</b>	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	Allow 1.33(...) for $\frac{4}{3}$	
	Allow 0.66(...) or 0.67 for $\frac{2}{3}$	
	$\pi$ may be seen as [3.14, 3.142]    eg Alt 1 $\frac{2}{3} \times 3.14 \times 9^3$	M1
	If a number (or calculation) in terms of $\pi$ is seen but $\pi$ is subsequently omitted, treat as a miscopy for M marks eg Alt 1 486 $\pi$ $0.8 \times 486 = 388.8$ $185 \times 7 = 1295$ Yes	M1 M1dep M1A0
	Yes cannot be implied by inequalities	
	Alts 1 and 2 $185 \text{ cm}^3 \times 7$ seen is M1 even if evaluated incorrectly $185^3 \times 7$ seen is M0 unless recovered to 1295	
	Do not allow misreads of the given formula unless recovered eg1 using $9^2$ instead of $9^3$ eg2 using $\frac{3}{4}$ instead of $\frac{4}{3}$	
	For $0.8 \times$ their $486\pi$ , do not accept $80\% \times$ their $486\pi$ unless recovered	

Q	Answer	Mark	Comments
12	$9 \div 4$ or $13.5 \div 6$ or $\frac{9}{4}$ or $\frac{13.5}{6}$ or 2.25 or $6 \div 4$ or $13.5 \div 9$ or $\frac{6}{4}$ or $\frac{13.5}{9}$ or 1.5	M1	oe use of a valid pair of sides to make an appropriate calculation or value eg $4 \div 9$ or 0.44(...) or $4 \div 6$ or 0.66(...)
	$9 \div 4 = 13.5 \div 6$ or $\frac{9}{4} = \frac{13.5}{6}$ or $6 \div 4 = 13.5 \div 9$ or $\frac{6}{4} = \frac{13.5}{9}$	A1	oe showing sides are in proportion eg $4 \div 9 = 6 \div 13.5$ or $\frac{4}{6} = \frac{9}{13.5}$
	<b>Additional Guidance</b>		
	For A1 equating may be implied by two calculations or two fractions with correct evaluation eg $9 \div 4 = 13.5 \div 6$ is implied by $9 = 4 \times 2.25$ and $13.5 = 6 \times 2.25$		M1A1
	For A1 equating may be implied by calculations eg1 $9 \div 4 = 13.5 \div 6$ is implied by $9 \div 4 = 2.25$ and $6 \times 2.25 = 13.5$		M1A1
	eg2 $9 \div 4 = 13.5 \div 6$ is implied by $\frac{9}{4} \times 6 = 13.5$		M1A1
	$4 \times 13.5 = 9 \times 6$		M1A1
	$4 \times 13.5 = 54$ and $9 \times 6 = 54$		M1A1
	Non-contradictory working can be ignored eg correct response along with area calculations		M1A1
	Ignore words eg references to scale factors, enlargement, angles		
Working on diagrams may be seen eg1 Arrows or lines from 4 to 9 and 6 to 13.5 with $\times 2.25$ on them eg2 Arrows or lines from 4 to 9 and 6 to 13.5 with 2.25 on them Arrows or lines must unambiguously link relevant numbers		M1A1 M1A0	
For $9 \div 4$ or $\frac{9}{4}$ allow $9 : 4$ etc			

Q	Answer	Mark	Comments
13	$100 \times x$ or $100x$ or $x \times 100$ or $x100$ or $x \div 60$ or $\frac{x}{60}$ or $\frac{1}{60}x$ or $x\frac{1}{60}$ or $100 \div 60$ or $\frac{100}{60}$	M1	plasters per hour  boxes per minute
	$\frac{100x}{60} \left( = \frac{5x}{3} \right)$ or $100 \div 60 \times x \left( = \frac{5x}{3} \right)$	A1	oe showing 100 and 60 and $x$ eg $\frac{100 \times x}{60} \left( = \frac{5x}{3} \right)$ or $x\frac{100}{60} \left( = \frac{5x}{3} \right)$ or $\frac{100}{60} \times x \left( = \frac{5x}{3} \right)$ or $100x \div 60 \left( = \frac{5x}{3} \right)$

**Question 13 additional guidance on the next page**

		<b>Additional Guidance</b>	
<b>13</b>		M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
		Do not allow M1 if only seen embedded in an incorrect expression or calculation eg $100x \times 5 = 500x$	M0
		$60 \times \frac{5x}{3} = 100x$ (M1 allowed as $100x$ is not embedded in an incorrect expression or calculation, A0 because using the given answer)	M1A0
		Condone $x = 100 \div 60$	M1A0
		$\frac{100x}{60} \left( = \frac{5x}{3} \right)$	M1A1
		$\frac{100}{60} = \frac{5}{3}$ and $\frac{5}{3} \times x \left( = \frac{5x}{3} \right)$	M1A1
		$\frac{100}{60} = \frac{5}{3}$ and $\frac{5x}{3}$	M1A0
		No equivalentents allowed for M1	
		Ignore units	
		Condone 1.66(...) for $\frac{5}{3}$	
	Ignore non-contradictory working after M1A1 seen		

Q	Answer	Mark	Comments
<b>14(a)</b>	<b>Alternative method 1</b> Works out best estimate of the percentage of employees with hourly rate more than £16		
	28 ÷ 2 or 14	M1	oe implied by 43 or 70
	(12 + 17 + their 14) ÷ 113 or 43 ÷ 113 or 0.38(...) or (56 + their 14) ÷ 113 or 70 ÷ 113 or 0.61(...) or 0.62	M1dep	oe eg (113 – 56 – their 14) ÷ 113 or [12, 12.4] (%) + 15(.0...) (%) + [10.6, 11] (%)
	38(.0...)(%) or 38.1(%)	A1	oe SC3 40 (or 39.55) and explains that a minimum of 11 of 28 people earn more than £16
	<b>Alternative method 2</b> Compares best estimate of the number of employees with hourly rate more than £16 with 35% of number of employees		
	28 ÷ 2 or 14	M1	oe implied by 43 or 70
	0.35 × 113 or 39.55 or 0.65 × 113 or 73.45	M1	oe accept 39.6 or 40 for 39.55 accept 73.5 or 73 or 74 for 73.45
	43 and 39.55 or 70 and 73.45	A1	accept 39.6 or 40 for 39.55 accept 73.5 or 73 or 74 for 73.45 SC3 40 (or 39.55) and explains that a minimum of 11 of 28 people earn more than £16

**Question 14(a) continues on the next page**

<b>14(a) cont</b>	<b>Alternative method 3</b> Shows that a value of $x$ gives a percentage $> 35\%$		
	$(17 + 12 + x) \div 113$ where $11 \leq x \leq 28$	M2	oe eg $(29 + x) \div 113$ must see 17 and 12 <b>or</b> 29
	$(17 + 12 + x) \div 113$ where $11 \leq x \leq 28$ and evaluates $(17 + 12 + x) \div 113 \times 100$ correctly	A1	evaluations rounded or truncated to nearest integer or better  SC3 40 (or 39.55) and explains that a minimum of 11 of 28 people earn more than £16
	<b>Alternative method 4</b> Shows a number of employees that gives a percentage $> 35\%$		
	$0.35 \times 113$ or 39.55	M1	oe accept 39.6 or 40 for 39.55
	$17 + 12 + x$ or $29 + x$ where $11 \leq x \leq 28$	M1dep	must see 17 and 12 <b>or</b> 29
	39.55 and evaluates $17 + 12 + x$ correctly where $11 \leq x \leq 28$	A1	accept 39.6 or 40 for 39.55  SC3 40 (or 39.55) and explains that a minimum of 11 of 28 people earn more than £16
	<b>Additional Guidance</b>		
	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	14 may be seen by the table		
	Alt 1 62% needs further explanation to score A1		
	Ignore irrelevant working in an otherwise fully correct response		
	For the SC3, minimum of 11 may be implied by an explanation that $12 + 17 + x$ is at least 40 or $29 + x$ is at least 40		
	Responses involving interpolation should be escalated		

Q	Answer	Mark	Comments
14(b)	Valid reason	B1	eg all employees in the second interval may earn less than £16
	<b>Additional Guidance</b>		
	Fewer than 11 employees could earn more than £16 per hour		B1
	Only 9 might get more than £16 in second class interval (9 could be replaced by any integer from 0 to 10 inclusive)		B1
	More than 11 in group 2 earn less than £16		B0
	Everyone in second group may earn 12 or 13 or 14 or 15		B1
	18 people may earn between £12 and £16 (18 could be replaced by any integer from 18 to 28 inclusive)		B1
	More people may earn between £12 and £16		B0
	People in the 12 to 20 group aren't evenly distributed		B0
	Not everyone in 12 – 20 earns more than £16		B0
	Not many in second group may get more than £16		B0
	Some of second group may get more than £16		B0
	12 to 20 includes people who get less than £16		B0
	2nd group includes some getting less than 16 and some getting more than 16		B0
	We don't know what each person earns		B1
	We don't know how many of 2nd group earn less than £16 per hour		B1
	Under £16 isn't in the data		B1
Grouped data or it is only an estimate or using midpoints or data is wrong		B0	
Ignore irrelevant working but do not ignore incorrect working			

Q	Answer	Mark	Comments
14(c)	10 × 56 or 560 and 16 × 28 or 448 and 30 × 17 or 510 and 50 × 12 or 600	M1	oe implied by 2118 may be seen by the table allow one product or $fx$ value to be incorrect
	(their 560 + their 448 + their 510 + their 600) ÷ 113 or 2118 ÷ 113	M1dep	oe eg $\frac{560 + 448 + 510 + 600}{56 + 28 + 17 + 12}$ condone bracket error if working seen eg $560 + 448 + 510 + 600 \div 113$
	18.7(4...)	A1	Allow 18.70 if M2 seen and no errors
	<b>Additional Guidance</b>		
	Four values with three correct from 560, 448, 510, 600 can score up to M2 if they add and divide by 113		
	Correct products or values seen but a different method used eg $113 \div 4$		M0M0
	18.7(4...) in working with answer given as the interval $12 \leq p < 20$		M2A0
	Ignore any references to statement B eg £18.74 which makes B wrong		M2A1
Do not allow rounding of any of their 4 values in the second mark eg 560 448 510 600 $(600 + 448 + 510 + 600) \div 113$		M1 M0	

Q	Answer	Mark	Comments
14(d)	Valid reason referring to the distribution	B1	eg most employees earned below £18
	<b>Additional Guidance</b>		
	Less than a half earned more than £18	B1	
	Lots earned 8 to 12	B0	
	29 people were over £20	B0	
	Not many earned more than the mean	B0	
	Most earned less than £18	B1	
	Some earned less than the mean, some earned more	B0	
	Mean is not a real amount of money	B0	
	Median is better or mode is better	B0	
	Modal class is $8 \leq p < 12$	B1	
	The mode is between £8 and £12 (condone mode as modal class)	B1	
	We don't know what each person earns	B0	
	Grouped data or it is only an estimate or using midpoints or data is wrong	B0	
	The range is large	B0	
	The data has extreme values or outliers or anomalous values	B1	
	The data is (positively) skewed	B1	
	The distribution is not symmetrical	B1	
	The distribution is not evenly spread	B1	
	Not representative	B0	
	Lots of low values or high values can make the mean inaccurate	B0	
Ignore irrelevant working but do not ignore incorrect working			

Q	Answer	Mark	Comments
15	$3a^3 + 2a^2b - 21a^2b - 14ab^2$	M1	exactly 4 terms with 3 correct terms in any order may be seen in a grid implied by $3a^3 - 19a^2b$ with one other term or $-19a^2b - 14ab^2$ with one other term
	$3a^3 + 2a^2b - 21a^2b - 14ab^2$ or $3a^3 - 19a^2b - 14ab^2$	A1	terms in any order do not allow if only seen in a grid
	<b>Additional Guidance</b>		
	A correct term includes the sign (in a grid allow eg $2a^2b$ for $+2a^2b$ )		
	Condone four correct terms followed by incorrect simplification of $a^2b$ terms, otherwise do not allow further incorrect work eg1 $3a^3 + 2a^2b - 21a^2b - 14ab^2 = 3a^3 + 19a^2b - 14ab^2$ eg2 $3a^3 - 2a^2b - 21a^2b - 14ab^2 = 6a^5b - 21a^2b - 14ab^2$		M1A1 M1A0
	Allow equivalent fully simplified terms eg $2a^2b$ may be seen as $2ba^2$		
	For M1 allow coefficients to be incorrectly positioned eg $a^33 + 2a^2b - b21a^2 - 14ab^2$		M1A0
	$3a^3 + 2a^2b - 21a^2b + -14ab^2$ has 4 correct terms but needs further simplification to score A1		M1A0
Terms must be processed eg do not allow $a^2 \times 3a$ for $3a^3$			

Q	Answer	Mark	Comments
16	$22 = 9a - 5$ or $(a =) 3$	M1	oe eg $\frac{22 - -5}{9 - 0}$ may be implied eg $(y =) 3x - 5$
	$(y =) \frac{5}{2}x \dots$ or (gradient B =) $\frac{5}{2}$	M1	oe eg (gradient B =) 2.5 allow $(y =) \frac{5x + 7}{2}$
	gradient A = 3 and gradient B = $\frac{5}{2}$	A1	oe eg $3 > \frac{5}{2}$ condone $3x > \frac{5}{2}x$
	<b>Additional Guidance</b>		
	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Condone incorrect $y$ -intercept eg $a = 3$ $y = \frac{5}{2}x + 7$ gradient A = 3     gradient B = $\frac{5}{2}$		M1M1  A1
	It must be clear that the values 3 and $\frac{5}{2}$ are being used to answer the question to award A1 eg1 gradient A = 3 and gradient B = $\frac{5}{2}$ (no statement needed) eg2 $a = 3$ $y = \frac{5}{2}x + \frac{7}{2}$ eg3 $y = 3x - 5$ and $y = \frac{5}{2}x + \frac{7}{2}$ 3 is greater than $\frac{5}{2}$ eg4 $y = 3x - 5$ and $y = \frac{5}{2}x + \frac{7}{2}$ gradient of A > gradient of B		M2A1 M2A0 M2A1 M2A0
$22 = 9x - 5$ or $x = 3$ must be recovered to award 1st M1			

Q	Answer	Mark	Comments
17	<b>Alternative method 1</b> Works out AC and uses it in triangle ABC		
	$\cos 42 = \frac{AC}{6}$	M1	oe eg $\sin 48 = \frac{AC}{6}$ allow 0.74(...) for cos 42 or sin 48
	(AC =) $6 \times \cos 42$ or (AC =) [4.45, 4.5]	M1dep	oe eg (AC =) $6 \times \sin 48$ allow 0.74(...) for cos 42 or sin 48 may be seen on diagram
	$\sin x = \frac{\text{their [4.45, 4.5]}}{11.7}$ or (x =) $\sin^{-1}[0.38, 0.385]$	M1dep	oe eg $\cos x = \frac{\sqrt{11.7^2 - \text{their [4.45, 4.5]}^2}}{11.7}$ or (x =) $90 - \cos^{-1}[0.38, 0.385]$
	[22.3, 23]	A1	
	<b>Alternative method 2</b> Works out angle ADC and uses it in triangle ABD		
	(angle ADC =) $90 - 42$ or (angle ADC =) 48	M1	oe eg (angle ADC =) $180 - 90 - 42$ may be seen on diagram
	$\frac{\sin x}{4} = \frac{\sin(90 - 42)}{11.7}$	M1dep	oe eg $\frac{6}{\sin x} = \frac{11.7}{\sin 48}$
	(sin x =) $\frac{\sin(90 - 42)}{11.7} \times 6$ or (x =) $\sin^{-1}[0.38, 0.385]$	M1dep	oe
	[22.3, 23]	A1	

Question 17 continues on the next page

		<b>Additional Guidance</b>	
<b>17 cont</b>		Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
		Allow any unambiguous notation for angles, eg allow $B$ for $x$	
		Alt 1 Allow any unambiguous notation for $AC$ eg $y$ (condone $x$ if clearly referring to $AC$ )	
		Alt 1 1st M1 must be an equation where $AC$ is the only variable eg $AC^2 + (6 \sin 42)^2 = 6^2$	M1
		Alt 1 A calculation that leads to $AC$ scores M1M1 eg $\sqrt{6^2 - (6 \sin 42)^2}$	M1M1
		Alt 1 3rd M1 must have $\sin x$ (or $\cos x$ ) as the subject or be a calculation that leads to $x$	
		Alt 2 48 only marked at angle $BAC$ on diagram	M0

Q	Answer	Mark	Comments
18	$xz = xy + 4$ or $z = y + \frac{4}{x}$	M1	oe equation with fraction eliminated or oe equation with single fraction split into two terms eg $x \times z = xy + 4$ or $z = \frac{xy}{x} + \frac{4}{x}$
	$xz - xy = 4$ or $x(z - y) = 4$	M1dep	oe equation with $x$ terms collected eg $xy - xz = -4$
	$x = \frac{4}{z - y}$ or $x = \frac{-4}{y - z}$	A1	oe equation with $x$ the subject eg $-\frac{4}{y - z} = x$
	<b>Additional Guidance</b>		
	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Correct answer in working with answer repeated on answer line without $x =$ eg $x = \frac{4}{z - y}$ seen in working with answer $\frac{4}{z - y}$		
Do not allow incorrect simplification after correct answer seen eg $x = \frac{4}{z - y}$ $x = \frac{4}{z} - \frac{4}{y}$			M2A0
$xz - xy - 4 = 0$ with no further correct working			M1M0

Q	Answer	Mark	Comments
19	<b>Alternative method 1</b> $nth\ term = an^2 + bn + c$		
	(second differences =) 10 or $a = 5$ or $5n^2$	M1	second difference seen at least once and not contradicted by a different value unless recovered may be seen by the sequence
	$6 - 5 \times 1^2$ and $24 - 5 \times 2^2$ <b>or</b> 1 and 4 <b>or</b> $b = 3$ <b>or</b> $3n$	M1dep	oe subtraction of $5n^2$ from any two consecutive terms eg $52 - 5 \times 3^2$ and $90 - 5 \times 4^2$ <b>or</b> 7 and 10 implied by $5n^2 + 3n \dots$
	$5 \times 1^2 + 3 \times 1 + c = 6$ or $5 + 3 + c = 6$ or ( $3n + c$ and) $3 \times 1 + c = 1$	M1dep	oe substitution of $a = 5$ and $b = 3$ eg $5 \times 2^2 + 3 \times 2 + c = 24$
	$5n^2 + 3n - 2$	A1	terms in any order SC2 $a = 5$ and $c = -2$ SC1 $c = -2$
	<b>Alternative method 2</b> $nth\ term = an^2 + bn + c$		
	(second differences =) 10 or $a = 5$ or $5n^2$	M1	second difference seen at least once and not contradicted by a different value unless recovered may be seen by the sequence
	$3 \times 5 + b = 18$ or $b = 3$ <b>or</b> $3n$	M1dep	oe substitution of $a = 5$ eg $5 \times 5 + b = 28$ implied by $5n^2 + 3n \dots$
	$5 \times 1^2 + 3 \times 1 + c = 6$ or $5 + 3 + c = 6$	M1dep	oe substitution of $a = 5$ and $b = 3$ eg $5 \times 2^2 + 3 \times 2 + c = 24$
	$5n^2 + 3n - 2$	A1	terms in any order SC2 $a = 5$ and $c = -2$ SC1 $c = -2$

Question 19 continues on the next page

<b>19 cont</b>	<b>Alternative method 3</b> $n$ th term = $an^2 + bn + c$		
	Any 3 of $a + b + c = 6$ $4a + 2b + c = 24$ $9a + 3b + c = 52$ $16a + 4b + c = 90$	M1	oe 3 equations
	$3a + b = 18$ and $5a + b = 28$ or $a = 5$ and $b = 3$	M1dep	oe pair of equations in $a$ and $b$ eg $8a + 2b = 46$ and $15a + 3b = 84$ implied by $5n^2 + 3n \dots$
	$5 \times 1^2 + 3 \times 1 + c = 6$ or $5 + 3 + c = 6$	M1dep	oe substitution of $a = 5$ and $b = 3$ eg $5 \times 2^2 + 3 \times 2 + c = 24$
	$5n^2 + 3n - 2$	A1	terms in any order SC2 $a = 5$ and $c = -2$ SC1 $c = -2$
	<b>Additional Guidance</b>		
	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Second differences = 10 scores M1 even if used incorrectly eg $10n \dots$		
	Condone $n = 5n^2 + 3n - 2$ or $5n^2 + 3n - 2 = 0$		M3A1
	Condone working in a different variable eg $5x^2 + 3x - 2$		M3A1
The 3rd method mark cannot be implied ie $c = -2$ is only awarded M3 if the previous two method marks are seen			
Alt 1 2nd M1 cannot be awarded for subtracting in the wrong order unless recovered			
SC2 or SC1 can be awarded from work seen in the working lines			
SC2 or SC1 can be implied by a quadratic answer eg1 answer $5n^2 + 6n - 2$ eg2 answer $10n^2 + 4n - 2$		SC2 SC1	

Q	Answer	Mark	Comments
20(a)	75	B1	
	<b>Additional Guidance</b>		
	75 unambiguously linked to $x$ on diagram with answer line blank		B1

Q	Answer	Mark	Comments
20(b)	It could be bigger or smaller than the answer to part (a)	B1	
	<b>Additional Guidance</b>		

Q	Answer	Mark	Comments
20(c)	No and valid statement	B1	eg AB and CD are not parallel or no $y = 50^\circ$ (alternate segment theorem)
	<b>Additional Guidance</b>		
	Angles may be seen on the diagram		
	No may be implied eg1 angle $ADC$ is not 50 eg2 angle $y$ is 50		B1 B1
	Allow unambiguous indication of angles eg $A$ and $D$ are both 65 so he is wrong		B1
	No and angle $ADC = 65^\circ$		B1
	$y$ is not 80 so no		B1
	No, neither angle is correct		B1
	No, he thinks $AB$ and $CD$ are parallel		B1
	No, he's used alternate angles		B1
	He has made mistakes		B0
	Ignore irrelevant working but do not ignore incorrect working		B0
	Responses saying he is correct		B0

Q	Answer	Mark	Comments
21	<b>Alternative method 1</b>		
	3200 ÷ 2500 or 1.28	M1	oe
	$\sqrt[5]{\text{their } 1.28}$ or [1.05 1.0506] or [5.0, 5.06]	M1dep	may be implied eg $\frac{r}{100} = [0.05, 0.0506]$
	5.1	A1	
	<b>Alternative method 2</b>		
	Trial of the form $2500 \times x^5$ with $1 < x \leq 1.1$ and correct evaluation	M1	allow correct evaluation truncated or rounded to nearest integer or better allow working year by year value of $x$ used must be seen
	Two trials of the form $2500 \times x^5$ each with $1 < x \leq 1.1$ and correct evaluations, one with answer < 3200 and one with answer > 3200	M1dep	allow correct evaluations truncated or rounded to nearest integer or better allow working year by year values of $x$ used must be seen
	5.1	A1	

Question 21 continues on the next page

		<b>Additional Guidance</b>																									
<b>21 cont</b>	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts																										
	<table border="1"> <tr><td>1.01</td><td>2627.525125</td></tr> <tr><td>1.02</td><td>2760.202008</td></tr> <tr><td>1.03</td><td>2898.185186</td></tr> <tr><td>1.051</td><td>3205.926703</td></tr> </table>	1.01	2627.525125	1.02	2760.202008	1.03	2898.185186	1.051	3205.926703	<table border="1"> <tr><td>1.0505</td><td>3198.308</td></tr> <tr><td>1.04</td><td>3041.632256</td></tr> <tr><td>1.05</td><td>3190.703906</td></tr> <tr><td>1.06</td><td>3345.563944</td></tr> <tr><td>1.07</td><td>3506.379327</td></tr> <tr><td>1.08</td><td>3673.320192</td></tr> <tr><td>1.09</td><td>3846.559887</td></tr> <tr><td>1.1</td><td>4026.275</td></tr> </table>	1.0505	3198.308	1.04	3041.632256	1.05	3190.703906	1.06	3345.563944	1.07	3506.379327	1.08	3673.320192	1.09	3846.559887	1.1	4026.275	
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1.09	3846.559887																										
1.1	4026.275																										
Alt 2 example of working year by year (allow intermediate values to be truncated or rounded to the nearest penny, also allow if given to the next penny) $2500 \times 1.03 = 2898.19$ $2898.19 \times 1.03 = 2985.1357$ (allow 2985.13 or 2985.14) $2985.13 \times 1.03 = 3074.6839$																											
Incorrect trials and evaluations can be ignored																											
5.1 from incorrect working eg $3200 - 2500 = 700$ $\sqrt[4]{700} = 5.1$		MOMOA0																									
Wrong answer with no correct method seen		MOMOA0																									
Apply the scheme that favours the student eg $2500 \times 1.05^5$ scores M1M1 using Alt 1																											
$\frac{3200 - 2500}{2500}$ with no further correct work		MOMO																									

Q	Answer	Mark	Comments
22(a)	$(x_2 =) 5.3(1\dots)$	B1	
	$(x_3 =) [5.553, 5.555]$ or 5.55	B1ft	ft their 5.3(1...) rounded to at least 2 dp SC1 $x_2 = [5.553, 5.555]$ or 5.55
	<b>Additional Guidance</b>		
	Allow second B1 for $x_3 = 5.6$ with acceptable answer seen in working		
	$x_2 = 12.247$ $x_3 = 9.986$		B0 B1ft
	SC1 is for using $x_0 = 5$		

Q	Answer	Mark	Comments
22(b)	$5.85 < \text{value} \leq 6.23$	B1	ignore any iteration number
	<b>Additional Guidance</b>		
	Ignore other values if B1 response seen		

Q	Answer	Mark	Comments
<b>23</b>	$\frac{3}{10} \times \frac{2}{9}$ or $\frac{6}{90}$ or $\frac{1}{15}$	M1	oe fraction, decimal or percentage allow $\frac{2}{9}$ to be 0.22(2...) or 22(.2...)% allow $\frac{6}{90}$ to be [0.066, 0.067] or [6.6, 6.7]% may be seen on a tree diagram allow 6 out of 90
	$\frac{1}{10} \times \frac{2}{9}$ or $\frac{2}{90}$ or $\frac{1}{45}$	M1	oe fraction, decimal or percentage allow $\frac{2}{90}$ to be 0.022(...) or 2.2(...)%  may be seen on a tree diagram allow 2 out of 90 or 4 out of 90
	$\frac{6}{90}$ and $\frac{2}{90}$	A1	oe fractions, decimals or percentages allow 6 out of 90 and 2 out of 90
	Probabilities in comparable form and Option 1	A1ft	ft their $\frac{6}{90}$ and their $\frac{2}{90}$ with M2A0 correct comparisons include $\frac{1}{15}$ and $\frac{1}{45}$ [0.066, 0.067] and 0.022(...) [6.6, 6.7]% and 2.2(...)% 6 out of 90 and 2 out of 90

**Question 23 continues on the next page**

<b>Additional Guidance</b>		
<b>23 cont</b>	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	3 ways to win in Option 1 and 2 ways to win in Option 2 so Option 1	M0M0A0A0
	Assuming replacement can score a maximum of M0M1A0A0	
	Choosing Option 1 cannot be implied by inequalities	

Q	Answer	Mark	Comments
24	44.5 or 45.5 or 65 or 75	M1	allow $45.\dot{4}9$ or $74.\dot{9}$ implied by 1980.25 or 2070.25 or 11881.5 or 12421.5 or 4225 or 5625
	6 × their $45.5^2$ – their $65^2$ or 6 × 2070.25 – 4225 or 12421.5 – 4225	M1	their 45.5 must be (45, 46] their 65 must be [60, 70)
	45.5 and 65 and 8196.5	A1	
	<b>Additional Guidance</b>		
	Up to M2 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	If multiple attempts are seen and one is fully correct, the correct one must be unambiguously selected (eg ticked or circled) to award A1 if the answer line is blank		
	Note that M0M1A0 is possible eg $6 \times 46^2 - 61^2$		M0M1A0
Condone eg 45.50 for 45.5			

Q	Answer	Mark	Comments
25	$\frac{(x-7)(x+4)}{(x-4)(x+4)} \text{ and } \frac{(x+7)(x-4)}{(x+4)(x-4)}$	M1	(x - 4)(x + 4) or $x^2 - 4x + 4x - 16$ must be seen (expansion may be seen in a grid) brackets in any order if the brackets are not shown for the numerators, expansions must be correct may be seen as a single fraction
	$x^2 - 7x + 4x - 28 \text{ or } x^2 - 3x - 28$ or $x^2 + 7x - 4x - 28 \text{ or } x^2 + 3x - 28$	M1	correct expansion of (x - 7)(x + 4) or (x + 7)(x - 4) ignore denominators may be seen in a grid implied by $2x^2 - 56$ if no errors seen in expansions
	M2 seen with no errors and $\frac{2x^2 - 56}{x^2 - 16}$	A1	allow M2 seen with no errors and $a = 2 \quad b = 56$
<b>Additional Guidance</b>			
	Missing brackets must be recovered but condone missing closing bracket at the end of a numerator or denominator eg $\frac{(x-7)(x+4)}{(x-4)(x+4)} + \frac{(x+7)(x-4)}{(x+4)(x-4)}$		1st M1
	2nd M1 is awarded for four correct terms even if subsequently simplified incorrectly		
	For terms seen in a grid, signs must be correct (allow eg 4x for + 4x)		
	For 1st M1 allow multiplication signs		
	After M2A1 ignore incorrect values stated eg $a = 2 \quad b = -56$		
	$\frac{2x^2 - 56}{x^2 - 16}$ may come from wrong working or incomplete working eg $\frac{(x-7)(x+4)}{(x-4)(x+4)} + \frac{(x+7)(x-4)}{(x+4)(x-4)}$ $\frac{x^2 - 28 + x^2 - 28}{x^2 - 16} = \frac{2x^2 - 56}{x^2 - 16}$		M1  M0A0

Q	Answer	Mark	Comments
26(a)	(0, -3)	B1	
	<b>Additional Guidance</b>		

Q	Answer	Mark	Comments
26(b)	$y = 2 - x^2$	B1	oe equation eg $x^2 = 2 - y$
	<b>Additional Guidance</b>		
	$y = -1x^2 + 2$		B1
	$y = -(x^2) + 2$		B1
	$-x^2 + 2$		B0

Q	Answer	Mark	Comments	
26(c)	Translation	B1	allow eg translate(d)	
	$\begin{pmatrix} 2 \\ 0 \end{pmatrix}$	B1		
	<b>Additional Guidance</b>			
	Do not accept a vector given as coordinates or with missing brackets or with 'fraction line'			
	Translation from (0, 0)			B1B0
	Translation horizontally by 2			B1B0
	Translate 2 to the right and 2 down			B1B0
	Reflect by $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$			B0B1
	Giving a combined transformation is B0B0			
	Ignore references to movement if vector is correct eg Move to the left by $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$			B0B1



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# GCSE MATHEMATICS 8300/3H

Higher Tier

Paper 3 Calculator

Shadow paper based on June 2023 paper

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**Mark scheme**

June 2023

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Version: 1.0

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [aqa.org.uk](http://aqa.org.uk)

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## Glossary for Mark Schemes

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

<b>M</b>	Method marks are awarded for a correct method which could lead to a correct answer.
<b>A</b>	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
<b>B</b>	Marks awarded independent of method.
<b>ft</b>	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
<b>SC</b>	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
<b>M dep</b>	A method mark dependent on a previous method mark being awarded.
<b>B dep</b>	A mark that can only be awarded if a previous independent mark has been awarded.
<b>oe</b>	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
<b>[a, b]</b>	Accept values between a and b inclusive.
<b>[a, b)</b>	Accept values $a \leq \text{value} < b$
<b>3.14...</b>	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
<b>Use of brackets</b>	It is not necessary to see the bracketed work to award the marks.

Examiners should consistently apply the following principles.

### **Diagrams**

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

### **Responses which appear to come from incorrect methods**

Whenever there is doubt as to whether a student has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the student. In cases where there is no doubt that the answer has come from incorrect working then the student should be penalised.

### **Questions which ask students to show working**

Instructions on marking will be given but usually marks are not awarded to students who show no working.

### **Questions which do not ask students to show working**

As a general principle, a correct response is awarded full marks.

### **Misread or miscopy**

Students often copy values from a question incorrectly. If the examiner thinks that the student has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

### **Further work**

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

### **Choice**

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

### **Work not replaced**

Erased or crossed out work that is still legible should be marked.

### **Work replaced**

Erased or crossed out work that has been replaced is not awarded marks.

### **Premature approximation**

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

### **Continental notation**

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the student intended it to be a decimal point.

Q	Answer	Mark	Comments
1	-3	B1	

Q	Answer	Mark	Comments
2	$\frac{117}{40}$ or $2\frac{37}{40}$	B1	oe fraction, eg $\frac{2925}{1000}$
	<b>Additional Guidance</b>		
	Ignore attempts to simplify after correct answer seen		
	Do not allow fractions with decimal numerators or denominators eg $\frac{29.25}{100}$		B0

Q	Answer	Mark	Comments
3	$10x - 4x$ or $6x$ or $4x - 10x$ or $-6x$ or $13 + 17$ or $30$ or $-17 - 13$ or $-30$	M1	
	5	A1	
	<b>Additional Guidance</b>		
	Answer 5 with no working or no incorrect working		M1A1
	Embedded answer eg $10 \times 5 - 17 = 4 \times 5 + 13$		M1A0

Q	Answer	Mark	Comments
4	$3.8 \times 6500$ or $24\,700$ or $6500 \div 100$ or $6.5$ or $3.8 \div 100$ or $0.038$	M1	
	247	A1	

Q	Answer	Mark	Comments
5	1 + 0.02 or 1.02 or 0.02 × 357 000 or 7140 or 364 140	M1	oe eg $1 + \frac{2}{100}$ 357 860 implies M1
	Full method for exactly 6 compounded percentage calculations with their multiplier	M1	oe eg 357 000 × their $1.02^6$
	[402 000, 403 000] with M2 awarded	A1	
	<b>Additional Guidance</b>		
	402039.(98...) or 402040 with M2 awarded		M1M1A1
	Answer 399 840 from 7140 × 6		M1M0A0
	Answer 399 840 without either 42 840 shown or M2 awarded		M0M0A0
	Intermediate values for separate calculations are 364 140, 371 442.(...), 378 851.(...), 386 428.(...), 394 156.(...)		

Q	Answer	Mark	Comments
	No ticked and correct reason or correct evaluation of the surface areas for any numerical or algebraic values or correct ratio of the surface areas	B2	eg 40 faces hidden B1 No ticked
<b>Additional Guidance</b>			
	Ignore irrelevant reasons or evaluations alongside a correct reason or evaluation, unless contradictory		
<b>6</b>	"No" may be implied by a correct reason		
	Accept reasoning that uses A as a cube		
	No ticked and A has 6, B has 32 (condone sides for faces) A has 3, B has 16 A has 6 sides, on B each cube only has 3 or 2 Ratio is 3 : 16 (accept equivalent ratios) The inside is missing (or covered) When they are put together you lose two faces Some of the faces are covered You cannot see some sides because they are stacked together		B2 B2 B2 B2 B2 B2 B2
	Yes ticked or Cannot tell ticked		B0

Q	Answer	Mark	Comments											
7(a)	12 and -3 in the correct positions	B2	B1 12 or -3 in the correct position											
	<b>Additional Guidance</b>													
	<table border="1" style="margin-left: auto; margin-right: auto;"> <tbody> <tr> <td style="text-align: center;"><math>x</math></td> <td style="text-align: center;">-3</td> <td style="text-align: center;">-2</td> <td style="text-align: center;">-1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;"><math>y</math></td> <td style="text-align: center;">21</td> <td style="text-align: center;">12</td> <td style="text-align: center;">5</td> <td style="text-align: center;">0</td> <td style="text-align: center;">-3</td> </tr> </tbody> </table>		$x$	-3	-2	-1	0	1	$y$	21	12	5	0	-3
$x$	-3	-2	-1	0	1									
$y$	21	12	5	0	-3									

Q	Answer	Mark	Comments
7(b)	Plots at least three points correctly	M1	correct or ft their table in (a) $\pm \frac{1}{2}$ small square points may be implied by graph passing through them
	Correct graph drawn through the five correct points	A1	$\pm \frac{1}{2}$ small square smooth (quadratic) curve
	<b>Additional Guidance</b>		
	Correct graph drawn without plotting the correct points		M1A1
	Ignore any extra points plotted		
	Ignore any part of graph drawn for $x < -3$ or $x > 1$		
	Ruled straight lines		A0

Q	Answer	Mark	Comments
8	<b>Alternative method 1</b>		
	5625 ÷ (2 + 7) or 5625 ÷ 9 or 625	M1	oe
	their 625 × 7 or 4375 or their 625 × 2 or 1250 or their 625 ÷ 5 or 125	M1dep	oe $5625 \times \frac{7}{9}$ is M2 $5625 \times \frac{7}{9}$ is M2 $5625 \div 45$ is M2
	their 4375 ÷ 5 or (5625 – their 1250) ÷ 5 or their 125 × 7 or 875	M1dep	oe dep on M2
	875 and Yes	A1	accept 875 > 870
	<b>Alternative method 2</b>		
	870 × 5 or 4350	M1	
	5625 ÷ (2 + 7) or 5625 ÷ 9 or 625	M1	oe
	their 625 × 7 or 4375 or their 625 × 2 or 1250	M1dep	oe dep on 2nd M $5625 \times \frac{7}{9}$ is M2 $5625 \times \frac{2}{9}$ is M2
	4350 and 4375 and Yes	A1	

Additional Guidance is on the next page

<b>Additional Guidance</b>		
<b>8 cont</b>	Up to M3 may be awarded for correct work, with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	Yes may be implied eg They receive 5 more than 870	M3A1
	Condone £875.00p and Yes	M3A1

<b>Q</b>	<b>Answer</b>	<b>Mark</b>	<b>Comments</b>
<b>9</b>	100 – 60 or 40 or 360 – 60 – 120 – 100 or 80	M1	oe implied by 1 degree = 0.3 people or 10 degrees = 3 people or 12 customers = 40 degrees
	$\frac{12}{40} \times 360$ or 108 or $\frac{12}{40} \times 60$ or 18 or $\frac{12}{40} \times 120$ or 36 or $\frac{12}{40} \times$ their 80 or $\frac{12}{40} \times (60 + 120 + 100)$ or 84	M1dep	
	24	A1	
	<b>Additional Guidance</b>		
	Up to M2 may be awarded for correct work, with no answer or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments
10	<b>Alternative method 1 – using sine of an angle</b>		
	sin chosen or used	M1	
	$\sin 35 = \frac{14}{x}$ or $x = \frac{14}{\sin 35}$ or $x \times \sin 35 = 14$	M1dep	oe
	[24.4, 25]	A1	
	<b>Alternative method 2 – using cosine of an angle</b>		
	cos chosen or used	M1	
	$\cos 55 = \frac{14}{x}$ or $x = \frac{14}{\cos 55}$ or $x \times \cos 55 = 14$	M1dep	oe
	[24.4, 25]	A1	
	<b>Alternative method 3 – finding adjacent first</b>		
	$\frac{14}{\tan 35}$ or $14 \times \tan 55$ or 19.9(...) or 20	M1	oe
	$\sqrt{(\text{their } 19.9(\dots))^2 + 14^2}$ or $\sqrt{592.(\dots)}$ or their 19.9(...) $\div \cos 35$ or their 19.9(...) $\div \sin 55$	M1dep	oe
	[24.4, 25]	A1	
	<b>Additional Guidance</b>		
	Do not accept scale drawing		
$\frac{\sin 35}{15} = \frac{\sin 90}{x}$		M1	

Q	Answer	Mark	Comments
11(a)	4 or 5	M1	May be implied by $2^3$ or 8
	4 and 5 and $\frac{2}{40}$ or $\frac{1}{20}$ or 0.05	A1	May be implied by $2^3$ or 8
	<b>Additional Guidance</b>		
	Do not allow exact calculations for M1A1 Eg $9.1039... = 9$ and $5.49 = 5$ and $\frac{2}{45}$		M1A0

Q	Answer	Mark	Comments
11(b)	Valid explanation	B1	eg the numbers on the bottom have been rounded down so that means it will make a larger number when it is divided into the top
	<b>Additional Guidance</b>		
	Ignore irrelevant reasons alongside a correct reason, unless contradictory		
	Ignore a calculation using exact values alongside a correct reason eg 0.05 is greater than 0.040 (...) with <b>valid</b> explanation		B1
	0.05 is greater than 0.040 (...)		B0
	The denominator is larger in the unrounded version		B1
	The denominator is smaller in the estimation		B1
	2 is divided by more (with answer less)		B1
	Estimating rounds the numbers down which makes the denominator less		B1
	Estimating rounds the numbers down which makes it less		B0

Q	Answer	Mark	Comments
12(a)	Bill and valid reason	B1	eg spun the most times
	<b>Additional Guidance</b>		
	Do not accept an incorrect reason alongside a correct response		
	Do not accept reasons which refer to the probability increasing		
	Ignore reasons that refer to results being more accurate		

Q	Answer	Mark	Comments
12(b)	Valid reason	B1	eg 3 does not divide into 100 exactly
	<b>Additional Guidance</b>		
	Do not accept an incorrect reason alongside a correct response		
	$\frac{1}{3} \times 100$ is not a whole number		B1
	Number of spins would be a decimal		B1
	Number of spins must be a whole number		B1
	Cannot land on the spinner 33.3... times		B1
	Have to spin 33.3... times		B0
	$\frac{1}{3} \times 100 = 33.3...$		B0
	33.3...		B0
	It is a decimal		B0
	Must be a whole number		B0

Q	Answer	Mark	Comments
12(c)	175 × 0.64 or 112 or 1 – 0.64 or 0.36	M1	oe
	63	A1	

Q	Answer	Mark	Comments
13	$90 \div 50$ or 1.8 or $\frac{9}{5}$ or 1 h 48 mins	M1	oe eg 108 mins  implied by 10 03 am
	$(154 - 90) \div 47$ or $64 \div 47$ or 1.361 ... or $\frac{64}{47}$ or 1 h 21 mins (42. (...) secs)	M1	oe eg 81.702 (...) mins
	their 1.8... + their 1.21 or $\frac{743}{235}$  or [3.01, 3.16]  or 3 h 10 mins  or [11 24 (am), 11.25 (am)]	M1dep	oe eg 189.7 ... mins dep on M2  accept 3 hrs 9 mins 42 secs for 3 h 10 mins implied by adding times eg $8.25 + 1.8 + 1.36 \dots$
	3.25 and [3.01, 3.26] and Yes or 3 h 10 mins and 3 h 15 mins and Yes or 190 mins and 195 mins and Yes or [11 25 (am), 11.26 (am)] and Yes	A1	oe arrival time must be in a comparable time format
	<b>Additional Guidance</b>		
	Up to M3 may be awarded for correct work seen in multiple attempts even if not subsequently used		
	Accept use of 24 hour clock throughout		
Do not accept 11 25 pm as a correct arrival time			

Q	Answer	Mark	Comments	
14	$600 \div 0.2$ or $600 \times 5$ or 3000	M1	oe	
	17 700	A1		
	$(\text{their } 17700 - 6500) \times 0.1575$ or $11200 \times 0.1575$	M1	their 17 700 must be $> 6500$ full method to calculate National Insurance	
	1764	A1ft	ft their 17 700, which must be $> 6500$	
	<b>Additional Guidance</b>			
	Accept final answer rounded or truncated to the nearest pound if a more accurate value is seen in working			
	Do not accept '15.75% of 11 200' or $15.75\% \times 11200$ for M mark unless accompanied by a correct method or value			
	$3000 \times 0.1575$ or 472.5(0)			M1A0M0A0ft

Q	Answer	Mark	Comments
15(a)	$48 \div (320 - 260)$ or $48 \div 60$ or 0.8	M1	may be on diagram
	$40 \times 2.4 (= 96)$ $20 \times 3.6 (= 72)$ $20 \times 1.6 (= 32)$	M1dep	allow 1 error or 1 omission or 1 misread of a frequency density value  may be on diagram.
	200	A1	

Q	Answer	Mark	Comments
15(b)	Rectangular box plot with whiskers to 150 and 200	B1	
	Lower quartile drawn at 163 and median drawn at 172	B1	
	Upper quartile drawn at 187	B1ft	correct or ft their lower quartile + 24 must be the vertical line at right side of their box
	<b>Additional Guidance</b>		
	Mark intention eg any height and allow horizontal line through centre of box		
	Allow ends of whiskers to be vertical lines of any length, dots, crosses or stops		
	$\pm \frac{1}{2}$ small square tolerance		
	Median must be the second vertical line of a box with three vertical lines		
Only vertical lines or points plotted	B0		

Q	Answer	Mark	Comments
16	<b>Alternative method 1 – using Pythagoras' theorem or 5, 12, 13 triangle</b>		
	39 ÷ 13 × 5 or 15(cm) or identifies triangle as 5, 12, 13	M1	oe length of $a$ may be on diagram
	$\sqrt{39^2 - (\text{their } 15)^2}$ or $\sqrt{1521 - 225}$ or $\sqrt{1296}$ or $3 \times 12$	M1dep	
	36 (cm)	A1	length of $b$ may be on diagram
	270	A1ft	ft $\frac{1}{2} \times \text{their } 36 \times \text{their } 15$ with M2 awarded
	<b>Alternative method 2 – using trigonometry and <math>\frac{1}{2}ab \sin C</math> formula</b>		
	39 ÷ 13 × 5 or 15 (cm)	M1	oe length of $a$ may be on diagram
	$\cos^{-1}\left(\frac{15}{39}\right)$ or 67.3(...) or 67.4	M1dep	angle between sides $a$ and $c$
	$\frac{1}{2} \times 39 \times 15 \times \sin(\text{their } 67.3(\dots))$	M1dep	dep on M2
	270	A1	
	<b>Additional Guidance</b>		
	$\frac{1}{2} \times 39 \times 15 \times \sin 90$		M1M1M1

Q	Answer	Mark	Comments
17	<b>Alternative method 1 – multiplies through by 10 or common denominator of 10</b>		
	$4(x - 4) + 3(10 - x)$ or $4x - 16 + 30 - 3x$	M1	oe numerator on the left-hand side if written as a fraction allow one error or omission in the expansion if brackets not seen eg $4x + 30 - 3x$
	$x + 14$	A1	
	their $(x + 14) = 1 \times (\text{their } 12)$ or their $(x + 14) = 12$ or $x + 2 = 0$	M1	oe allow an unsimplified expression for their $(x + 14)$ equation may be implied by answer
	-2	A1ft	ft M1A0M1
	<b>Alternative method 2 – collects terms with fractions</b>		
	$\frac{x}{3} - \frac{4}{3} + \frac{10}{4} - \frac{x}{4}$	M1	oe eg $\frac{1}{3}x - \frac{4}{3} + 2.5 - 0.25x$ allow one error
	$\frac{1}{12}x + \frac{7}{6}$	A1	oe
	$\frac{1}{12}x = 1 - \frac{7}{6}$ or $\frac{1}{12}x = -\frac{1}{6}$	M1	oe terms must be collected
	-2	A1ft	ft M1A0M1

Additional Guidance is on the next page

<b>Additional Guidance</b>		
<b>17 cont</b>	Accept decimal answers for follow through correct to 1 dp or better	
	Apply the principles of alt 1 for any use of other common denominators eg common denominator of 24 (or multiplication through by 24) $8(x - 4) + 6(10 - x) = 2x + 28$ $2x + 28 = 24 \quad x = -2$	M1A1 M1A1
	An incorrect simplification of $4x - 16 + 30 - 3x$ may still gain the third and fourth marks eg $4x - 16 + 30 - 3x = x + 46$ followed by $x + 46 = 12$ and $x = -34$	M1A0M1 A1ft M1A0M1 A1ft
	An incorrect denominator may still gain the third and fourth marks $\frac{4x - 16 + 30 - 3x}{7}$ followed by $4x - 16 + 30 - 3x = 7$ and $x = -7$	M1A0M1 A1ft
	Denominator not processed $x + 14 = 1$ followed by $x = -13$	M1A1M0A0
	$(x - 4) + (10 - x) = 12$	M0A0M1A0

Q	Answer	Mark	Comments
18(a)	$3(x+3)^2 - (x+3)$	M1	may be seen in a grid
	$3(x^2 + 6x + 9) - x - 3$ or $3x^2 + 18x + 27 - x - 3$	M1dep	fully expanded expression with terms summed allow one omission or one arithmetic error
	$3x^2 + 18x - x + 27 - 3$ and $3x^2 + 17x + 24$	A1	
	<b>Additional Guidance</b>		
	$3x^2 + 27 - x + 3$ is two errors		

Q	Answer	Mark	Comments
18(b)	$3x^2 + 17x + 19 (= 0)$	M1	must be correct
	$x = \frac{-17 \pm \sqrt{17^2 - 4(3)(19)}}{2 \times 3}$ or $x = \frac{-17 \pm \sqrt{61}}{6}$	M1dep	oe implies first M1
	$(x =) -4.14$ and $(x =) -1.53$	A1	cao
	<b>Additional Guidance</b>		
	SC2 from using $3x^2 + 17x + 29 (= 0)$		
	Trial and improvement with both answers correct and chosen from any list		M1M1A1
Trial and improvement with one answer correct		M0M0A0	

Q	Answer	Mark	Comments	
19	Creates an algebraic product in the form $(x + a)(x + b)$ where there is a difference of 2 between $a$ and $b$	M1	accept any letter for $x$ eg $x(x + 2)$ or $x^2 + 2x$ or $x(x - 2)$ or $x^2 - 2x$	
	Correctly expands their product, adds 1 and simplifies to a quadratic expression	M1dep	eg $x^2 + 2x + 1$ or $x^2 - 2x + 1$	
	Correctly factorises their quadratic expression to the form $(x + c)^2$ with M2 awarded	A1	eg $(x + 1)^2$ or $(x - 1)^2$	
	<b>Additional Guidance</b>			
	Trialling integers scores no marks, but ignore any testing of values alongside correct algebra			
	Ignore any further work or attempts to solve after correct answer seen			
	Missing brackets may be recovered, eg $x \times x + 2$ followed by $x^2 + 2x + 1$			M1M1
$(x + 1)(x + 1)$ without $(x + 1)^2$ seen does not score the A mark				

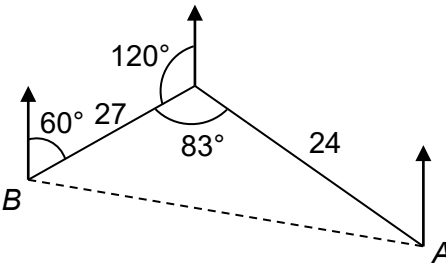
Q	Answer	Mark	Comments
20(a)	Substitutes a correct pair of coordinates and states that the equation is incorrect	B1	eg $E = \frac{14}{2} = 7$ and the graph is [7.4 ,7.5] so he is wrong.
	<b>Additional Guidance</b>		
	Accept 'No' or a cross or any clear indication that he is incorrect		
	Do not accept pairs of values not on the graph		
	Do not accept a correct answer alongside an incorrect response unless clearly chosen		
Do not accept a coordinate with no substitution seen			

Q	Answer	Mark	Comments
20(b)	<b>Alternative method 1</b>		
	$G \propto H^2$ or $G = kH^2$ or $10 \div 1 \times 5 = k(100)$ or $50 = k(100)$	M1	oe equation  $k$ may be any letter
	$k = \frac{50}{100}$ or $k = 0.5$ or $G = \text{their } 0.5H^2$	M1dep	their 50 must be the result of $10 \div 1 \times 5$
	their $0.5 \times \text{their } 20^2$ or 200	M1dep	dep on M2
	200 : 20 or 10 : 1	A1	oe ratio
	<b>Alternative method 2</b>		
	20 $\div$ 10 or 2	M1	
	2 <sup>2</sup> or 4	M1dep	
	5 $\times$ their 4 or 20 or 50 $\times$ their 4 or 200	M1dep	dep on M2
	200 : 20 or 10 : 1	A1	oe ratio
	<b>Additional Guidance</b>		
	Ignore an incorrect attempt to simplify a correct ratio eg 200 : 20 followed by 20 : 10		M1M1M1A1
	$k = 0.5$ implies M2 unless from incorrect working		
	$G \propto kH^2$ is M0 unless recovered		

Q	Answer	Mark	Comments
21	$7 \times 5 \times 6$ or $7 \times 5 + 7 \times 5$	M1	
	210 or 70	A1	
	Maximum 210 and Minimum 70	A1	

Q	Answer	Mark	Comments
22	Reflection	B1	
	Straight line drawn on diagram passing through the points (0, 7) and (7, 0)	B1	soi getting a correct answer of $x + y = 7$ oe implies this mark.
	In the line $x + y = 7$	B1	oe eg $y = 7 - x$
	<b>Additional Guidance</b>		
	Do not accept rotation as the first B1 Do not accept "mirror" or "flip" for first B1		

Q	Answer	Mark	Comments
23(a)	Angle $YXZ = 38$ and Angle $YZX = 64$ and sine rule indicated	M1	May be seen on diagram.  If sine and cosine rule are quoted then it must be clear that the sine rule has been selected as the one to use.
	$\frac{206 \times \sin 38}{\sin 64} = 141.10\dots$	A1	$YZ = 141.1071473\dots$
	<b>Additional Guidance</b>		
	Using sine rule with $\sin 38$ and $\sin 64$ transposed	M1A0	

Q	Answer	Mark	Comments
23(b)	<b>Alternative method 1</b>		
	$16 \times 1.5 (= 24)$ or $18 \times 1.5 (= 27)$ or $240(^{\circ}) - 157(^{\circ}) = 83(^{\circ})$ or $360(^{\circ}) - 240(^{\circ}) = 120(^{\circ})$ or $180(^{\circ}) - 120(^{\circ}) = 60(^{\circ})$	M1	 <p>Values may be seen on a diagram as above.</p>
	$AB = \sqrt{24^2 + 27^2 - (2 \times 24 \times 27 \times \cos 83)}$ (= 33.8682...)	M1ft	If a diagram is seen for M1 then ft their 27, 24 and 83 if it has been clearly substituting into the cosine formula
	$\sin^{-1}\left(\frac{24 \sin 83}{\text{their } 33.8682\dots}\right)$ (= 44.69651534...)	M1ft	Use of sine rule to calculate angle <i>OBA</i> . Again if a diagram is seen then ft their values if they are clearly substituted into the sine rule formula
	105°	A1	or better 104.69651534
	<b>Additional Guidance</b>		
There is no follow through from part (a)			
Accept any notation for the angle, eg $\sin x$ or $\sin C$ for angle <i>OBA</i>			