AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE MATHEMATICS

H

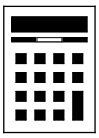
Higher Tier Paper 3 Calculator

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

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



Instructions

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

Information

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

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	
26–27	
TOTAL	

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

Do not write outside the box

1 Circle the smallest number.

[1 mark]

4.31 $4.\dot{3}$ 4.301 4.33

2 Work out $\begin{pmatrix} -4 \\ 8 \end{pmatrix} - \begin{pmatrix} 3 \\ -2 \end{pmatrix}$

Circle your answer.

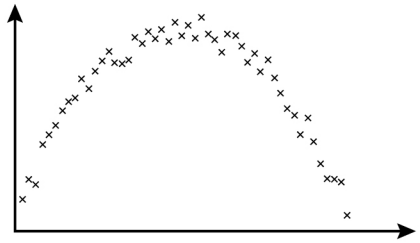
[1 mark]

$\begin{pmatrix} -7 \\ 10 \end{pmatrix}$ $\begin{pmatrix} -7 \\ 6 \end{pmatrix}$ $\begin{pmatrix} -1 \\ 10 \end{pmatrix}$ $\begin{pmatrix} -1 \\ 6 \end{pmatrix}$

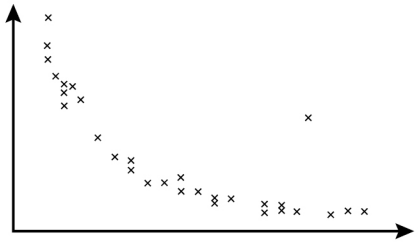
Do not write outside the box

3 Here are four scatter graphs.

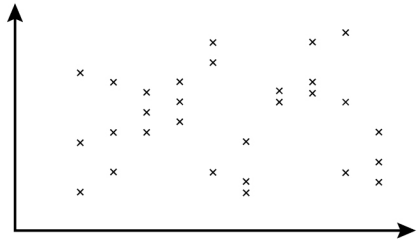
Graph A



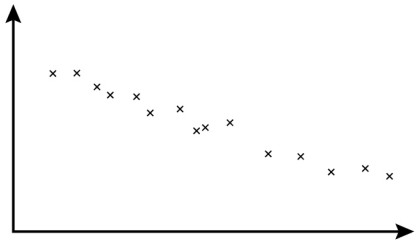
Graph B



Graph C



Graph D



3 (a) For which graph is a straight line of best fit appropriate?
Circle your answer.

[1 mark]

A B C D

3 (b) Which graph has **one** outlier?
Circle your answer.

[1 mark]

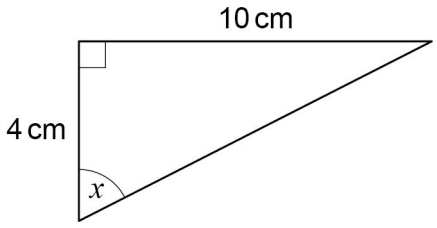
A B C D

4

Do not write outside the box

4 Use trigonometry to work out the size of angle x.

Not drawn accurately



[3 marks]

$x =$ _____ °

Do not write outside the box

5 Laura works in a shop.

The table shows the number of hours she works on two weekends.

	Saturday	**Sunday**
Weekend 1	3	2
Weekend 2	$5\frac{1}{2}$	$3\frac{1}{2}$

Work out the percentage increase in her **total** hours from Weekend 1 to Weekend 2

[3 marks]

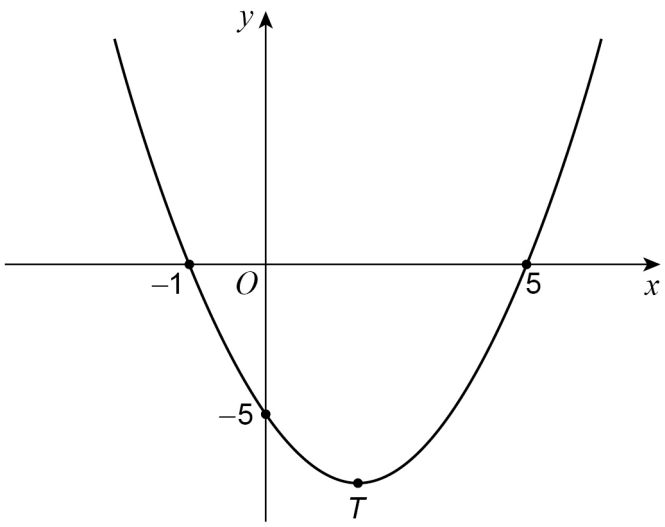
Answer _____ %

Turn over for the next question

6

Do not write outside the box

6 Here is a sketch of the curve $y = x^2 - 4x - 5$



6 (a) Write down the **two** roots of $x^2 - 4x - 5 = 0$

[1 mark]

Answer _____ and _____

6 (b) Work out the coordinates of *T*, the turning point of the curve.

[2 marks]

Answer (_____ , _____)

Do not write outside the box

7 A is an **arithmetic** progression.

Here are the first four terms.

13 16 19 22

G is a **geometric** progression.

Here are the first four terms.

2 4 8 16

nth term of A = 8th term of G

Work out the value of n.

[4 marks]

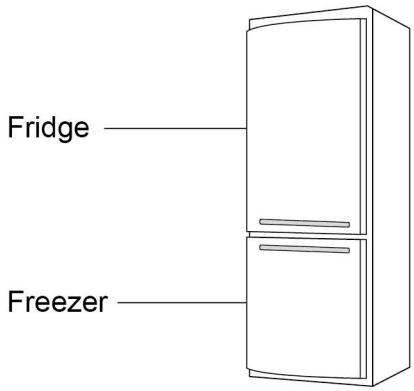
$n =$ _____

7

Do not write outside the box

8 Information about two fridge-freezers, A and B, is shown.

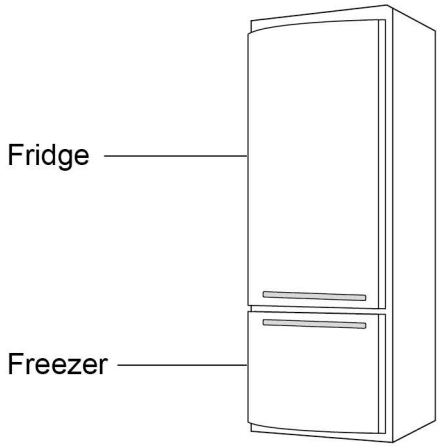
A



Total capacity is 330 litres

fridge capacity : freezer capacity = 3 : 2

B



Fridge capacity is 294 litres

fridge capacity : freezer capacity = 7 : 3

Do not write outside the box

Grace buys one of these fridge-freezers.

She buys the one with the greater **freezer** capacity.

Which one does she buy?

You **must** show your working.

[4 marks]

Answer _____

Turn over for the next question

4

Do not write outside the box

9 Tom and Adil are the two runners in a 200-metre race.

Tom completes the race in 24 seconds.

Adil completes the race at an average speed of 28.8 kilometres per hour.

Who wins the race?

You **must** show your working.

[3 marks]

Answer _____

Do not write outside the box

10 The mass of a baby is 3.6 kilograms to 1 decimal place.

What is the error interval for the mass in kilograms?

Tick **one** box.

[1 mark]

☐ $3.5 \leqslant \text{mass} \leqslant 3.6$

☐ $3.55 \leqslant \text{mass} \leqslant 3.65$

☐ $3.5 \leqslant \text{mass} < 3.6$

☐ $3.55 \leqslant \text{mass} < 3.65$

11 A quadrilateral has angles 70°, 110°, 130° and 50°

Circle the possible type of quadrilateral.

[1 mark]

kite parallelogram rhombus trapezium

Turn over for the next question

5

Do not write outside the box

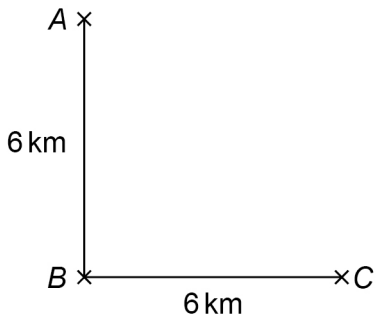
12 (a) *B* is

6 km due South of *A*

and

6 km due West of *C*.

Not drawn accurately



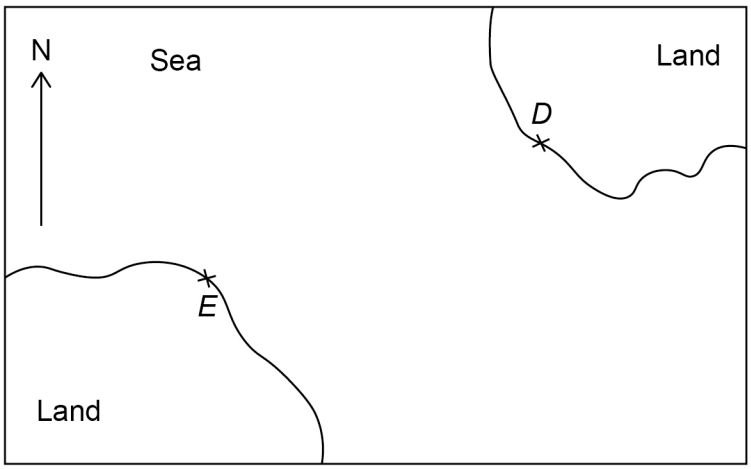
Work out the bearing of *A* from *C*.

[2 marks]

Answer _____ °

Do not write outside the box

12 (b) Here is a scale drawing.



A ship is going to sail from *D* to *E*.

Mia works out that the ship needs to sail on a bearing of 068°

Why must Mia be wrong?

[1 mark]

13 Simplify $\sqrt{5}\,a + \sqrt{5}\,a$

Circle your answer.

[1 mark]

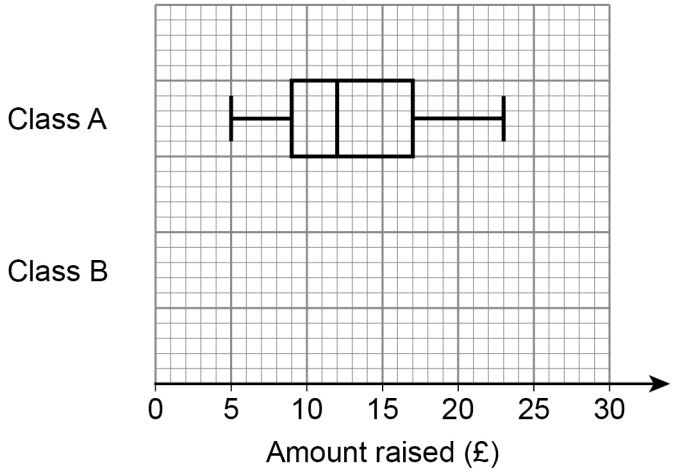
$5a$ $5a^2$ $2\sqrt{5}\,a$ $\sqrt{10}\,a$

4

Do not write outside the box

14 Students in two classes, A and B, raised money for charity.

The box plot for class A is shown on the grid.



For class B,

- the lowest amount was £3 and the highest amount was £26
- the lower quartile was £11
- the median was £2 greater than the class A median
- the interquartile range was $1\frac{1}{2}$ times greater than the class A interquartile range.

Draw the box plot for class B on the grid.

[4 marks]

Do not write outside the box

15 A town has

a population density of 278 people per km^2

and

a population of 158 460

$$\text{population density} = \frac{\text{population}}{\text{area}}$$

The population increases to 168 720

Work out the population density after the increase.

[3 marks]

Answer _____ people per km^2

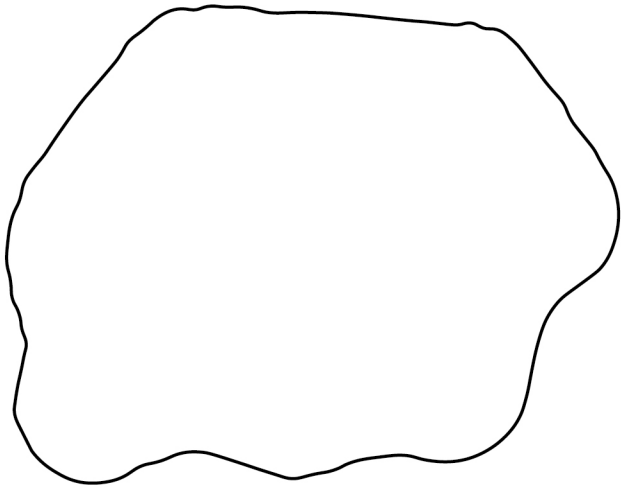
7

Turn over ►

Do not write outside the box

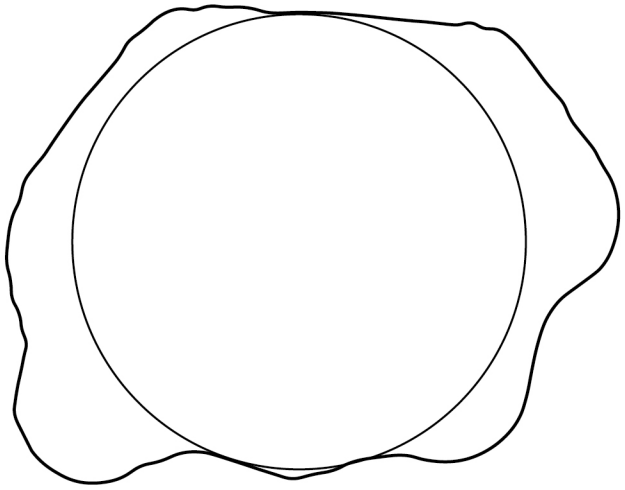
16 Here is a scale drawing of a reservoir.

Scale: 1 cm represents 500 m



Virat wants to estimate the volume of water in the reservoir.

He draws on the scale drawing a circle with radius 3 cm



Do not write outside the box

16 (a) Virat estimates the volume of the reservoir by assuming that

- the reservoir is a cylinder whose cross section is the circle
- the depth of the reservoir is 17 metres.

Work out Virat's estimate in cubic metres.

[3 marks]

Answer _____ m^3

16 (b) In fact,

- the depth of the reservoir is 13.8 metres
- the reservoir is **not** a cylinder (see diagram).

Which statement about the actual volume of the reservoir is correct?

Tick **one** box.

☐ It is less than Virat's estimate

☐ It is greater than Virat's estimate

☐ It could be less than or greater than Virat's estimate

Give a reason for your answer.

[2 marks]

5

Do not write outside the box

17 In a video game, players make their own character.

They choose one of each from

8 faces

4 bodies

5 hairstyles.

17 (a) How many different characters can be made?

[2 marks]

Answer _____

17 (b) Two characters are made at random.

What is the probability that they are exactly the same?

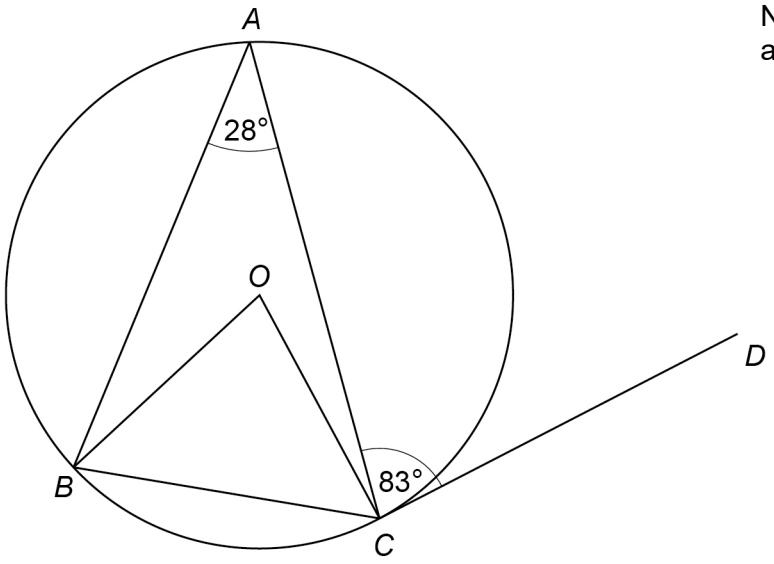
[1 mark]

Answer _____

Do not write outside the box

18 *A*, *B* and *C* are points on a circle, centre *O*.

DC is a tangent to the circle.



Not drawn accurately

Show that angle *ABO* : angle *ACO* = 3 : 1

[5 marks]

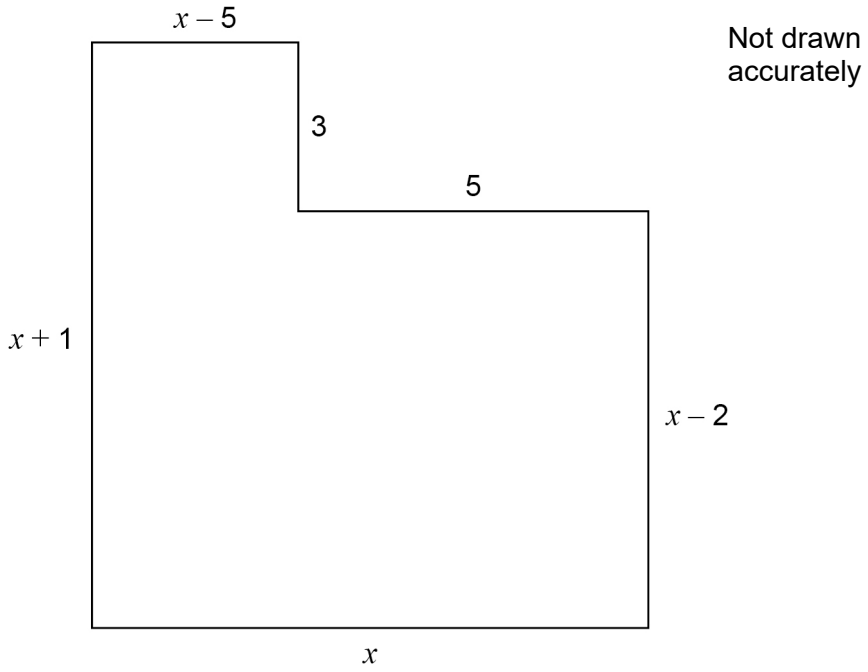
8

Turn over ►

Do not write outside the box

19 Here is the plan of the floor of an L-shaped room.

All lengths are in metres.



Not drawn accurately

19 (a) The area of the floor is $75\,m^2$

Show that $x^2 + x - 90 = 0$

[3 marks]

Do not write outside the box

19 (b) By factorising $x^2 + x - 90$ work out the value of x.

You **must** show your working

[2 marks]

$x =$ _____

20 £2448 is invested in an account at a rate of compound interest.
One year after the investment there is £2496.96 in the account.

How much is in the account four years after the investment?

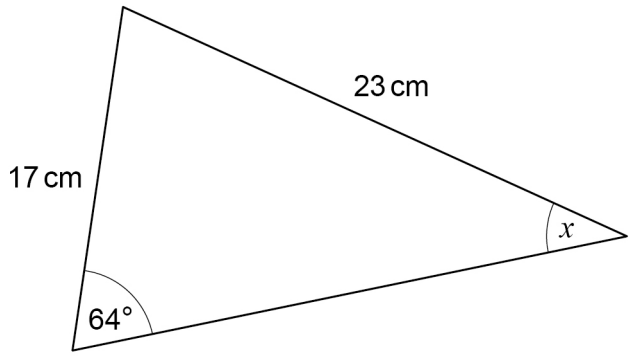
[3 marks]

Answer £ _____

8

Do not write outside the box

21



Not drawn accurately

Use the sine rule to work out the size of angle x.

[3 marks]

$x =$ _____ °

22 $f(x) = 3x$ and $g(x) = x^2$

Circle the expression for $fg(x)$

[1 mark]

$3x^2$ $9x^2$ $3x^3$ $9x^4$

Do not write outside the box

23 Here are two simultaneous equations.

$y = x^2 + 7x - c$

and

$y = 3x + d$

There is a solution when $x = 5$

Work out the value of $c + d$

[3 marks]

Answer _____

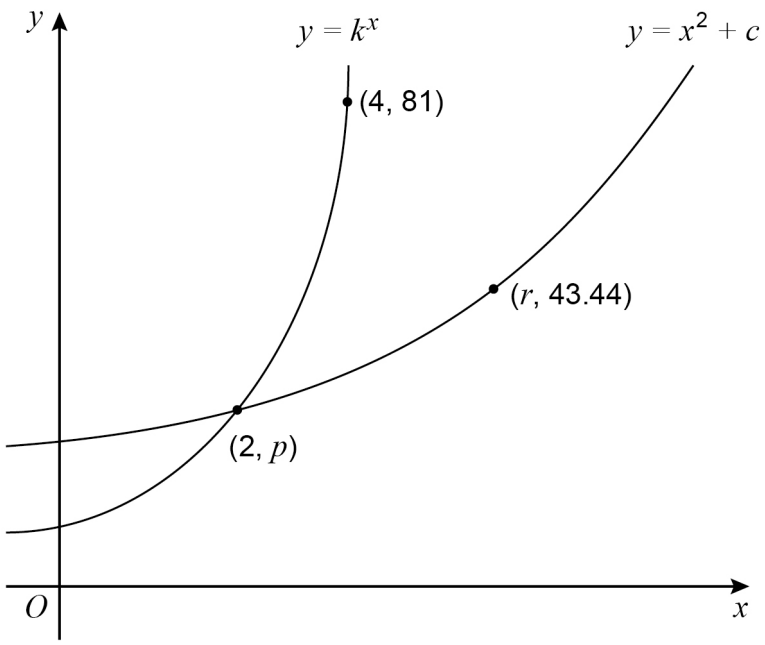
Turn over for the next question

7

Do not write outside the box

24 Here is a sketch of the graphs of $y = k^x$ and $y = x^2 + c$

k and c are positive constants.



Work out the value of r.

[4 marks]

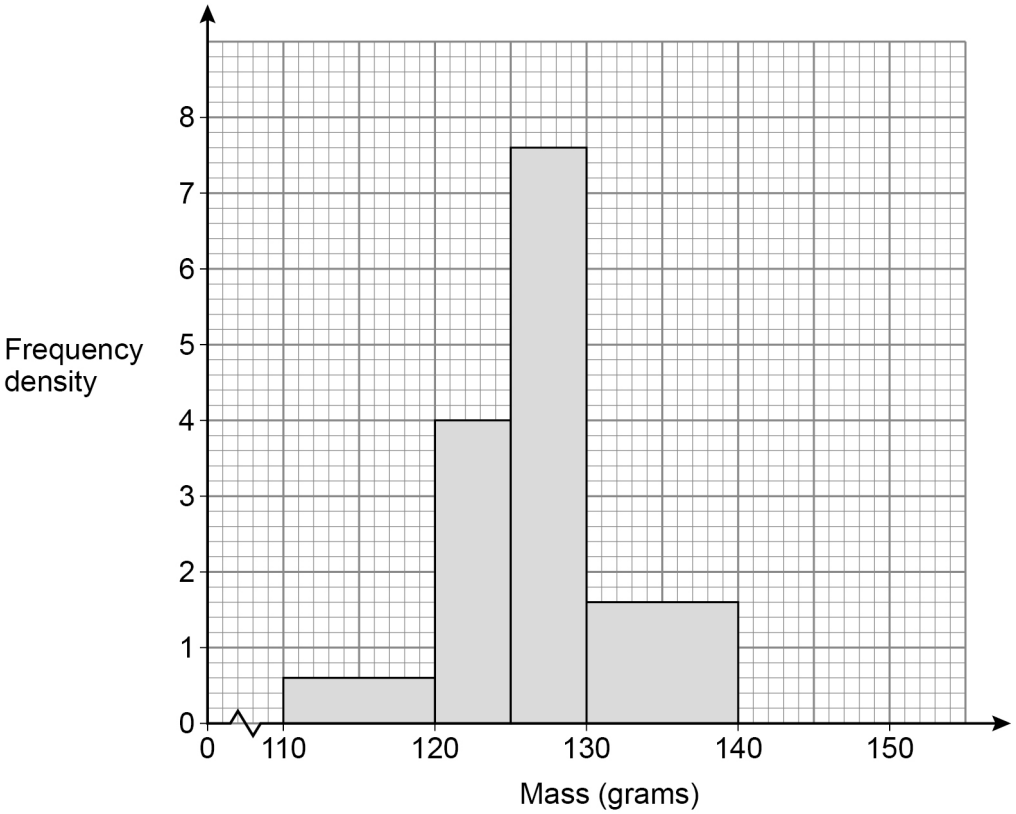
$r =$ _____

Do not write outside the box

25 A company makes tubes of toothpaste.

The masses of 80 tubes are checked.

A histogram is drawn to represent the data.



The company makes 28 000 tubes each day.

Estimate how many tubes each day have a mass **less than** 122 grams.

[4 marks]

Answer _____

8

Turn over ►

Do not write outside the box

26 Q and R are two numbers.

As a product of prime factors,

$Q = 2^3 \times 3 \times a^3$

$R = 2^4 \times 3^2 \times a^2$

26 (a) The highest common factor (HCF) of Q and R is 4056

Work out the value of a.

[2 marks]

$a =$ _____

26 (b) Work out the lowest common multiple (LCM) of Q and R.

[2 marks]

Answer _____

Do not write outside the box

27 Expand and simplify fully $(x-3)(x-4)(x+8)$

[3 marks]

Answer _____

END OF QUESTIONS

7

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

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GCSE
MATHEMATICS
8300/3H

Higher Tier Paper 3 Calculator

Mark scheme

June 2022

Version: 1.0 Final

2 2 6 G 8 3 0 0 / 3 H / M S

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

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.

M	Method marks are awarded for a correct method which could lead to a correct answer.
A	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	Marks awarded independent of method.
ft	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
SC	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
M dep	A method mark dependent on a previous method mark being awarded.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
oe	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
[a, b]	Accept values between a and b inclusive.
[a, b)	Accept values a $\leqslant$ value $<$ b
3.14…	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
Use of brackets	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	4.301	B1	

Q	Answer	Mark	Comments
2	$\begin{pmatrix} -7 \\ 10 \end{pmatrix}$	B1	

Q	Answer	Mark	Comments
3(a)	D	B1	

Q	Answer	Mark	Comments
3(b)	B	B1	

Q	Answer	Mark	Comments
4	**Alternative method 1**		
	tan identified	M1	oe eg $\tan^{-1}$
	$\tan x = \frac{10}{4}$ or $\tan x = \frac{5}{2}$ or $\tan x = 2.5$	M1dep	oe eg $\tan^{-1}\frac{10}{4}$ or $90 - \tan^{-1}\frac{4}{10}$
	[68, 68.2]	A1	SC1 [21.8, 22]
	Alternative method 2		
	$\sin x = \frac{10}{\sqrt{4^2+10^2}}$ or $\cos x = \frac{4}{\sqrt{4^2+10^2}}$	M2	oe eg $\sin x = \frac{10}{\sqrt{116}}$ or $\sin^{-1}\frac{10}{\sqrt{4^2+10^2}}$ or $\cos x = \frac{4}{\sqrt{116}}$ or $\cos^{-1}\frac{4}{\sqrt{4^2+10^2}}$ or $90 - \sin^{-1}\frac{4}{\sqrt{4^2+10^2}}$ or $90 - \cos^{-1}\frac{10}{\sqrt{4^2+10^2}}$
	[68, 68.2]	A1	SC1 [21.8, 22]
	Additional Guidance		
	Accept 10.77 or 10.8 or $2\sqrt{29}$ for $\sqrt{116}$		
	Tan can be identified by, for example, circling TOA in SOHCAHTOA		
	Answer from accurate drawing		M0M0A0
	$\sin x = \frac{10 \sin 90}{\sqrt{116}}$		M2
	(x =) tan 2.5 or (x =) tan 0.4 or (x =) $\tan\left(\frac{10}{4}\right)^{-1}$ unless recovered		M1M0A0
	$\tan = \frac{10}{4}$ or $\tan = \frac{4}{10}$ or $\tan x = \frac{4}{10}$ with no further correct working		M1M0A0

Q	Answer	Mark	Comments
5	$3 + 2$ or 5 and $5\frac{1}{2} + 3\frac{1}{2}$ or 9 **or** $5\frac{1}{2} - 3$ or $2\frac{1}{2}$ and $3\frac{1}{2} - 2$ or $1\frac{1}{2}$ **or** 4	M1	oe eg $180 + 120$ or 300 and $330 + 210$ or 540 implied by $5\frac{1}{2} + 3\frac{1}{2} - 3 - 2$
	$\frac{9-5}{5}$ or $\frac{2\frac{1}{2}+1\frac{1}{2}}{3+2}$ or $\frac{4}{5}$ or 0.8 or $\frac{5\frac{1}{2}+3\frac{1}{2}}{3+2}$ $(\times 100)$ or $\frac{9}{5}$ $(\times 100)$ or 1.8 $(\times 100)$ or 180	M1dep	oe eg $\frac{5\frac{1}{2}+3\frac{1}{2}-3-2}{3+2}$ eg $\frac{540-300}{300}$ or $\frac{240}{300}$ or $1.8 - 1$
	80	A1	

Additional Guidance

Allow working fully in minutes but units must be consistent in a single calculation	
eg 2 h 30 and 1 h 30	M1
eg $3 + 2 = 5$ and $330 + 210 = 540$	M1
eg $3 + 120$ and $330 + 3\frac{1}{2}$ unless recovered	M0
$3 + 2 = 6$, $5\frac{1}{2} + 3\frac{1}{2} = 9$, $9 - 6 = 3$, $3 = 50\%$	M1M1A0
$3 + 2 = 6$, $5\frac{1}{2} + 3\frac{1}{2} = 9$, answer 50% (3 is implied)	M1M1A0
$9 - 6 = 3$, $3 = 50\%$ (no method shown for 6)	M0M0A0

Q	Answer	Mark	Comments
6(a)	–1 and 5	B1	either order
	Additional Guidance		
	Ignore $x =$ written before answers		
	(–1, 0) or (5, 0)		B0

Q	Answer	Mark	Comments
6(b)	(2, –9)	B2	B1 $x = 2$ or (2, …) or $y = -9$ or (…, –9) or $(x-2)^2 - 9$ B1ft correct y-coordinate for their x-coordinate with $x \neq -1$, 0 or 5 SC1 (–9, 2)
	Additional Guidance		
	If answer line is blank, check diagram for indication of x or y values		
	(3, –9)		B1
	(3, –8)		B1ft
	(1, –8)		B1ft
	(2.5, –8.75)		B1ft
	(0, –5)		B0ft

Q	Answer	Mark	Comments
7	(8th term =) 2^8 or 256	M1	oe may be implied
	Common difference of A indicated as 3	M1	may be implied eg $3n$ … or … + $3(n-1)$
	$3n + 10$ = their 256 or (their 256 – 10) ÷ 3 or (their 256 – 13) ÷ 3 or 81	M1dep	oe equation eg $13 + 3(n-1) = 2^8$ dep on 2nd M1 their 256 may be any number and may be in index form
	82	A1	
	Additional Guidance		
	n + 3 implies 2nd M1		
	Do not award M1 for 256 if it is in a list of powers of 2 unless it is indicated or it is the highest power evaluated		
	Common difference of 3 may be shown on the progression for the 2nd M1		
	10, (13, 16, 19, 22), 25 without common difference of 3 shown does not imply 2nd M1		
	82 from trial and improvement		M3A1
	Embedded answer $3 \times 82 + 10 = 256$		M3A0
	$3n + 10 = 256$ or $3n + 10 = 2^8$ or $3n = 246$		M1M1M1
	$3n - 10 = 256$		M1M1M0
	$3n + 10 = 16$ (2^8 not seen)		M0M1M1
	$3n + 6 = 2^8$		M1M1M0
	256 – 22 = 234, 234 ÷ 3 (indicating common difference of 3)		M1M1M0
	$3n - 8 = 128$ (2^8 not seen)		M0M1M0

Q	Answer	Mark	Comments
8	330 ÷ (3 + 2) or 330 ÷ 5 or 66	M1	oe eg $\frac{330}{5}$
	their 66 × 2 or 132	M1dep	oe $\frac{2}{5}$ × 330 scores M2
	294 ÷ 7 or 42 or 294 ÷ 7 × 3 or 126	M1	oe eg $\frac{294}{7}$ or $\frac{3}{7}$ × 294
	132 and 126 and A	A1	
	Additional Guidance		
	132 and 88.2 and A		M1M1M0A0

Q	Answer	Mark	Comments
9	**Alternative method 1 – compares speeds in m/s**		
	200 ÷ 24 or 8.3(3…)	M1	oe eg $\frac{200}{24}$ or $8\frac{1}{3}$
	28.8 × 1000 ÷ 60 ÷ 60 or 8	M1	oe eg 28 800 ÷ 3600 or 28.8 ÷ 3.6
	8 and 8.3(3…) and Tom	A1	oe eg 8 and $8\frac{1}{3}$ and Tom
	Alternative method 2 – compares speeds in km/h		
	200 ÷ 24 or 8.3(3…)	M1	oe eg $\frac{200}{24}$ or $8\frac{1}{3}$
	their 8.3(3…) ÷ 1000 × 60 × 60 or 30	M1dep	oe eg 0.008 3(3…) × 3600
	30 and Tom	A1	
	Alternative method 3 – time for Adil starting with m/s		
	28.8 × 1000 ÷ 60 ÷ 60 or 8	M1	oe eg 28 800 ÷ 3600
	200 ÷ their 8 or 25	M1dep	oe eg $\frac{200}{8}$
	25 and Tom	A1	oe eg Tom by 1s
	Alternative method 4 – time for Adil starting with km/h		
	$\frac{200 \div 1000}{28.8}$ or [0.0069, 0.007] or $\frac{200}{28.8}$ or [6.9, 7]	M1	oe eg $\frac{0.2}{28.8}$ eg $\frac{125}{18}$
	their [0.0069, 0.007] × 60 × 60 or their [6.9, 7] ÷ 1000 × 60 × 60 or 25	M1dep	oe eg $\frac{0.2}{28.8}$ × 3600
	25 and Tom	A1	oe eg Tom by 1s

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments
9 cont	**Alternative method 5 – distance for Adil in 24s**		
	28 800 × 24 or 691 200 or 28.8 ÷ 60 ÷ 60 or 0.008 or 28.8 × 24 or 691.2	M1	oe eg $\frac{3456}{5}$
	their 691 200 ÷ 60 ÷ 60 or their 0.008 × 1000 × 24 or their 691.2 × 1000 ÷ 60 ÷ 60 or 192	M1dep	oe eg 28 800 × 24 ÷ 3600
	192 and Tom	A1	
	Additional Guidance		
	Up to M2 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	Ignore all units		
	Allow other correct comparisons eg 500 and 480 (this is metres per minute) eg 500 and 480 and Tom		M1M1 M1M1A1
	200 m = 0.2 km, 24 s = 24 ÷ 60 ÷ 60 = $\frac{1}{150}$ hour, 0.2 ÷ $\frac{1}{150}$ = 30 and Tom		M1M1A1
	$\frac{200 \div 1000}{24} = \frac{1}{120}$ (or 0.0083…)		M1

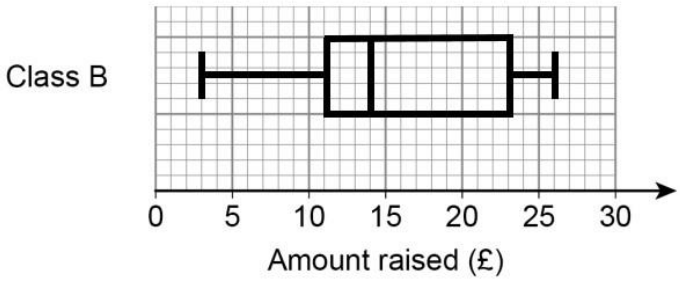
Q	Answer	Mark	Comments
10	$3.55 \leqslant$ mass < 3.65	B1	

Q	Answer	Mark	Comments
11	trapezium	B1	

Q	Answer	Mark	Comments
12(a)	$\frac{180-90}{2}$ or $\tan^{-1}\frac{6}{6}$ or 45	M1	oe may be seen on diagram eg $\sin^{-1}\left(\frac{6}{\sqrt{72}}\right)$
	315	A1	SC1 answer of 135 (bearing of *C* from *A*)
	Additional Guidance		
	$\tan\frac{6}{6}$ unless recovered		M0

Q	Answer	Mark	Comments
12(b)	Correct explanation that the ship would be on land or 068° is the bearing of *D* from *E* or the bearing must be over 180° or the actual bearing is [246, 250]°	B1	eg that would take the ship over land 068° is from *E* 068° is the bearing from *E* to *D* the bearing is 248°
	Additional Guidance		
	Ignore irrelevant statements and compass points eg bearings go clockwise, bearings are measured from north, NE, south west		
	Do not accept incorrect statement or bearing alongside a correct statement		
	Bearings measured or stated outside of [246, 250]° range		B0
	Examples of statements		
	Must be over 180°		B1
	Should be reflex		B1
	This is going from *E*		B1
	Makes the ship go in the opposite direction		B1
	68° needs to be 248°		B1
	Should be 248°		B1
	Her bearing cannot be acute		B1
	Bearings cannot be acute		B0
	248° without a statement		B0
	Ship would not land at *E*		B0
	She needs to go south west		B0

Q	Answer	Mark	Comments
13	$2\sqrt{5}\,a$	B1	

Q	Answer	Mark	Comments
14	Rectangular boxplot with whiskers to 3 and 26	B1	must have a rectangular box with whiskers
	Lower quartile at 11	B1	must be first vertical line of a box with three vertical lines
	Median at 14	B1	must be second vertical line of a box with three vertical lines
	Upper quartile at 23	B1ft	ft their LQ + 12 must be vertical line at right side of their box
	Additional Guidance		
	Correct boxplot  		
	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 missing		
	$\pm\frac{1}{2}$ small square tolerance		
	Only vertical lines or points plotted		B0

Q	Answer	Mark	Comments
15	**Alternative method 1**		
	158 460 ÷ 278 or 570	M1	
	168 720 ÷ their 570	M1dep	
	296	A1	
	Alternative method 2		
	158 460 ÷ 168 720 or 0.939… or 0.94	M1	
	278 ÷ their 0.939…	M1dep	
	296	A1	
	Alternative method 3		
	168 720 ÷ 158 460 or 1.0647… or 1.065 or 1.06	M1	oe eg $1+\frac{168720-158460}{158460}$ or $1+\frac{10260}{158460}$
	278 × their 1.0647…	M1dep	
	296	A1	
	Additional Guidance		
	278 × 1.065 = 296		M1M1A1
	278 × 1.065 = 296.07 with 296 on answer line is evidence of premature rounding in their working		M1M1A0
	168720 ÷ 158460 = 1.06, 278 × 1.06 = 294.68 with answer 294		M1M1A0
	Embedded answer eg 168720 ÷ 296 = 570		M1M1A0

Q	Answer	Mark	Comments
16(a)	3×500 or 1500	M1	actual radius of circle in metres
	(their 1500)$^2 \times \pi \times 17$ or $38\,250\,000\pi$	M1dep	
	[120 000 000, 120 200 000] or [1.2×10^8, 1.202×10^8]	A1	accept in words eg 120 million SC1 [480, 481] or [0.048, 0.0481]
	Additional Guidance		
	Do not award A mark if incorrect further work is seen		

Q	Answer	Mark	Comments
16(b)	It could be less than or greater than Virat's estimate (3rd box ticked) and statement that area is larger but depth is smaller	B2	B1 It is less than Virat's estimate (1st box ticked) and statement that depth is smaller or It is greater than Virat's estimate (2nd box ticked) and statement that area is larger or It could be less than or greater than Virat's estimate (3rd box ticked) and statement that depth is smaller or It could be less than or greater than Virat's estimate (3rd box ticked) and statement that area is larger

Additional Guidance	
For B2 their statement must refer to larger area and smaller depth	
For B1 their statement must correctly refer to larger area or smaller depth for their box ticked	
Examples of statements implying actual depth is smaller: height is less depth is lower it is shallower Virat's estimate of the depth is bigger	
Examples of statements implying actual area is larger: the width is bigger cross section is bigger shape is greater Virat's estimate of the area is smaller	
The reservoir could be bigger or smaller	B0
The reservoir is larger	B0
We do not know the depth	B0

Q	Answer	Mark	Comments
17(a)	$8 \times 4 \times 5$	M1	
	160	A1	
	Additional Guidance		
	$\frac{1}{8} \times \frac{1}{4} \times \frac{1}{5}$ = 160 (recovered)		M1A1
	$\frac{1}{8} \times \frac{1}{4} \times \frac{1}{5}$		M0A0

Q	Answer	Mark	Comments
17(b)	$\frac{1}{160}$ or 0.00625 or 0.625% or 6.25×10^{-3}	B1ft	oe fraction, decimal or percentage ft $\frac{1}{\text{their answer to (a)}}$
	Additional Guidance		
	Accept decimal or percentage answers rounded to 2 sf or better for ft eg ft 17 gives 0.058823529… so accept 0.059 or better		
	Ignore an attempt to convert a fraction to a decimal or round a decimal or percentage after a correct value is seen		
	1 : 160 or 1 in 160 or 1 out of 160		B0
	$\frac{1}{160} + \frac{1}{160} = \frac{2}{320} = \frac{1}{160}$		B0
	$\frac{1}{160} \times \frac{1}{160} = \frac{2}{320} = \frac{1}{160}$		B0

Q	Answer	Mark	Comments
18	**Alternative method 1 – using angles around *O* and angles inside arrowhead**		
	ACO = 90 – 83 or *ACO* = 7	M1	may be seen on diagram
	Acute *BOC* = 2 × 28 or acute *BOC* = 56	M1	may be seen on diagram
	Reflex *BOC* = 360 – their 56 or reflex *BOC* = 304	M1dep	may be seen on diagram dep on 2nd M1
	ABO = 360 – their 304 – their 7 – 28 or *ABO* = 21	M1dep	may be seen on diagram dep on M3
	ABO = 21 and *ACO* = 7 and 21 : 7 = 3 : 1	A1	all angle values must be seen
	Alternative method 2 – with line *OA* added		
	ACO = 90 – 83 or *ACO* = 7	M1	may be seen on diagram
	OAC = 7 or *ABO* + *ACO* = 28	M1dep	may be seen on diagram
	OAB = 28 – 7 or *OAB* = 21 or *ABO* = 28 – 7	M1dep	may be seen on diagram dep on M2
	ABO = 21	M1dep	may be seen on diagram dep on M3
	ABO = 21 and *ACO* = 7 and 21 : 7 = 3 : 1	A1	all angle values must be seen

Mark scheme continues on the next page

Q	Answer	Mark	Comments
18 cont	**Alternative method 3 – using alternate segment theorem**		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram
	$ABC = 83$	M1	may be seen on diagram
	$OBC = \frac{180 - \text{their } 56}{2}$ or $OBC = 62$ and $ABO = 83 -$ their 62 or $ABO = 21$	M1dep	may be seen on diagram, dep on 2nd and 3rd M1
	$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments	
18 cont	**Alternative method 4 – using triangles *OBC* and *ABC***			
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram	
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram	
	$OBC = \frac{180 - \text{their } 56}{2}$ or $OBC = 62$	M1dep	may be seen on diagram or angle *OCB* dep on 2nd M1	
	$ABO = 180 - 28 - 62 - 62 - 7$ or $ABO = 21$	M1dep	oe may be seen on diagram dep on M3	
	$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen	
	Additional Guidance			
	If angles are not correctly positioned on the diagram they must be correctly identified in the working, eg $BOC = 56$ is M0 if not correctly positioned on the diagram and not identified as acute			
	$ACO = 7$ and $ABO : ACO = 21 : 7$ with no other correct working			M1M0M0M0A0

Q	Answer	Mark	Comments
19(a)	**Alternative method 1 – horizontal split**		
	$x(x-2)$ and $3(x-5)$	M1	oe may be seen as two areas
	$x^2-2x+3x-15$ (= 75)	M1dep	oe expression with all brackets expanded
	$x^2-2x+3x-15=75$ and $x^2+x-90=0$ or $x^2+x-15=75$ and $x^2+x-90=0$	A1	with full working seen
	Alternative method 2 – vertical split		
	$(x-5)(x+1)$ and $5(x-2)$	M1	oe may be seen as two areas
	$x^2-5x+x-5+5x-10$ (= 75) or $x^2-4x-5+5x-10$ (= 75)	M1dep	oe expression with all brackets expanded
	$x^2-5x+x-5+5x-10=75$ and $x^2+x-90=0$ or $x^2-4x-5+5x-10=75$ and $x^2+x-90=0$	A1	with full working seen
	Alternative method 3 – large rectangle subtract 3 × 5		
	$x(x+1)$ and 3×5	M1	oe may be seen as two areas
	x^2+x-15 (= 75)	M1dep	oe expression with brackets expanded and 3×5 evaluated
	$x^2+x-15=75$ and $x^2+x-90=0$	A1	with full working seen

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments
19(a) cont	**Alternative method 4 – split into three areas**		
	$3(x-5)$ and $(x-2)(x-5)$ and $5(x-2)$	M1	oe may be seen as three areas
	$3x-15+x^2-2x-5x+10+5x-10$ (= 75) or $3x-15+x^2-7x+10+5x-10$ (= 75)	M1dep	oe expression with all brackets expanded
	$3x-15+x^2-2x-5x+10+5x-10=75$ and $x^2+x-90=0$ or $3x-15+x^2-7x+10+5x-10=75$ and $x^2+x-90=0$	A1	with full working seen
	Additional Guidance		
	Ignore attempts to solve the equation or substituting values for x		
	Condone missing end bracket for M1		
	Condone missing pairs of brackets if recovered eg $3\times x-5$ recovered to $3x-15$		

Q	Answer	Mark	Comments
19(b)	$(x - 9)(x + 10)$ (= 0) and answer 9	B2	B1 $(x - 9)(x + 10)$ (= 0) and answer 9 and –10 SC1 $(x + 9)(x - 10)$ (= 0) and answer 10
	Additional Guidance		
	If no response is seen, check part (a) for any creditworthy work		
	Answer 9 with no working can be awarded up to B2 from correct factorising seen in part (a)		
	Answer 9 from quadratic formula or completing the square		B1
	Answer 9 and –10 from quadratic formula or completing the square		B0
	Answer from trial and improvement only		B0

Q	Answer	Mark	Comments
20	**Alternative method 1**		
	2496.96 ÷ 2448 or 1.02	M1	implied by correct value for 2, 3 or 4 years
	2496.96 × (their 1.02)^3 or 2448 × (their 1.02)^4 or 2649.79…	M1dep	oe eg full year by year method shown
	2649.77 or 2649.78 or 2649.79 or 2649.8(0)	A1	accept 2650(.00) with M2 awarded SC2 2702.78 or 2702.79 or 2702.8(0)
	Alternative method 2		
	(2496.96 – 2448) ÷ 2448 or 48.96 ÷ 2448 or 0.02 or 2%	M1	
	2496.96 × $(1 + \frac{\text{their } 2}{100})^3$ or 2448 × $(1 + \frac{\text{their } 2}{100})^4$ or 2649.79…	M1dep	oe eg full year by year method shown
	2649.77 or 2649.78 or 2649.79 or 2649.8(0)	A1	accept 2650(.00) with M2 awarded SC2 2702.78 or 2702.79 or 2702.8(0)
	Additional Guidance		
	Calculated by year, the amounts would be: 2 years 2546.89 or 2546.90 3 years 2597.82 or 2597.83 or 2597.84		
	Condone 2650.0		M1M1A1
	2546.89, 2597.83, 2649.78, 2702.77 do not award A mark if further work seen after correct answer		M1M1A0
	$\frac{48.96}{2496.96} \times 100 = 2\%$ is incorrect working		M0M0A0

Q	Answer	Mark	Comments
21	$\frac{\sin x}{17} = \frac{\sin 64}{23}$ or $\sin x = \frac{17\sin 64}{23}$ or $\sin x = \frac{15.279...}{23}$ or $\frac{\sin x}{17} = 0.039\ldots$ or $\sin x = 0.66(4\ldots)$	M1	oe $\frac{17}{\sin x} = \frac{23}{\sin 64}$ or $\frac{17}{\sin x}$ = [25.58, 25.6]
	$(x =) \sin^{-1} \frac{17\sin 64}{23}$ or $(x =) \sin^{-1} 0.66(4\ldots)$	M1dep	
	[41.29, 41.64] or 42 or 41 from correct working	A1	
	Additional Guidance		
	Answer from accurate drawing		M0M0A0

Q	Answer	Mark	Comments
22	$3x^2$	B1	

Q	Answer	Mark	Comments
23	**Alternative method 1**		
	$5^2 + 7 \times 5 - c$ or $60 - c$ and $3 \times 5 + d$ or $15 + d$	M1	oe
	$25 + 35 - c = 15 + d$ or $60 - c = 15 + d$ or $c = 60 - y$ and $d = y - 15$ and $c + d = 60 - y + y - 15$	M1dep	oe equation with squaring and multiplications correctly completed
	45	A1	
	Alternative method 2		
	$x^2 + 7x - c = 3x + d$ or $x^2 + 7x - c - (3x + d) = 0$ or $x^2 + 7x - c - 3x - d = 0$ or $3x + d - (x^2 + 7x - c) = 0$ or $3x + d - x^2 - 7x + c = 0$	M1	oe
	$(c + d =)\ x^2 + 7x - 3x$ or $(c + d =)\ x^2 + 4x$ and substitutes $x = 5$	M1dep	oe
	45	A1	
	Additional Guidance		
	Once $c + d = 45$ is seen, ignore further attempts to find values for c or d		
	45 on answer line with no working or no incorrect working		M1M1A1

Q	Answer	Mark	Comments
24	$\sqrt[4]{81}$ or $81^{\frac{1}{4}}$ or $k = 3$	M1	may be seen on diagram and is implied by $p = 9$
	(their value for k)$^2 = 2^2 + c$ or $9 = 4 + c$ or $c = 5$	M1	does not need to be evaluated
	r^2 + their 5 = 43.44 or $\sqrt{43.44 - \text{their } 5}$ or $\sqrt{38.44}$	M1dep	oe equation dep on previous mark
	6.2	A1	
	Additional Guidance		
	Coordinate (2, 9) implies $p = 9$		

Q	Answer	Mark	Comments
25	0.6×10 or 6 or 4×5 or 20 or 7.6×5 or 38 or 1.6×10 or 16 or 4×2 or 8 or 4×3 or 12	M1	may be seen written on correct bar correct method for any frequency
	$0.6 \times 10 + (122 - 120) \times 4$ or $0.6 \times 10 + 2 \times 4$ or $0.6 \times 10 + \frac{2}{5} \times 4 \times 5$ or $6 + 8$ or 14 or $16 + 38 + \frac{3}{5} \times 4 \times 5$ or 66	M1dep	oe
	$14 \times \frac{28\,000}{80}$ or $28\,000 - 66 \times \frac{28\,000}{80}$ or 23 100	M1dep	oe eg 14×350 $28\,000 - 66 \times 350$
	4900	A1	SC3 3850 or 6475
	Additional Guidance		
	$0.3 \times 10 + 2 \times 4 = 11$ and $\frac{11}{80} \times 28\,000 = 3850$		SC3
	$1.3 \times 10 + 7.3 \times 5 + 4 \times 3 = 61.5$ and $28\,000 - \frac{61.5}{80} \times 28\,000 = 6475$		SC3
	$\frac{6+8}{80} \times 28\,000$ or $\frac{14}{80} \times 28\,000$		M3

Q	Answer	Mark	Comments
26(a)	$2^3 \times 3 \times a^2$ or $24a^2$ (= 4056) or $(a^2 =) \frac{4056}{2^3 \times 3}$ or $(a^2 =)$ 169 or $\sqrt{169}$	M1	oe eg $8 \times 3 \times a^2$
	13	A1	
	Additional Guidance		
	Condone $a^2 \times 24$ for M1		
	Fully correct prime factor decomposition with values 2, 2, 2, 3, 13, 13 shown without 13 chosen as the final answer		M1A0
	Embedded answer $2^3 \times 3 \times 13^2$		M1A0
	$\pm$ 13 or -13		M1A0
	$4056 \div 2^3 \times 3$ unless recovered to 169		M0A0

Q	Answer	Mark	Comments
26(b)	$2^4 \times 3^2 \times a^3$ or $144a^3$ or $2^4 \times 3^2 \times$ (their 13)^3 or $13 \times 4056 \times 2 \times 3$ or 52728×6 or 24336×13	M1	oe eg $144 \times$ (their 13)^3 $16 \times 9 \times 2197$
	316 368	A1ft	ft their 13, which must be an integer > 13
	Additional Guidance		
	eg 14 on answer line in part (a) can follow through to $144 \times 14^3 =$ 395 136		M1A1ft

Q	Answer	Mark	Comments
27	**Alternative method 1: multiplies $(x-3)(x-4)$ first**		
	$x^2-3x-4x+12$ or $x^2-7x+12$	M1	four terms with at least three correct implied by x^2-7x+k where k is a non-zero constant
	$x^3-3x^2-4x^2+12x+8x^2-24x-32x+96$ or $x^3-7x^2+12x+8x^2-56x+96$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and 8
	$x^3+x^2-44x+96$	A1	
	Alternative method 2: multiplies $(x-3)(x+8)$ first		
	$x^2-3x+8x-24$ or $x^2+5x-24$	M1	four terms with at least three correct implied by x^2+5x+k where k is a non-zero constant
	$x^3-3x^2+8x^2-24x-4x^2+12x-32x+96$ or $x^3+5x^2-24x-4x^2-20x+96$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and -4
	$x^3+x^2-44x+96$	A1	
	Alternative method 3: multiplies $(x-4)(x+8)$ first		
	$x^2-4x+8x-32$ or $x^2+4x-32$	M1	four terms with at least three correct implied by x^2+4x+k where k is a non-zero constant
	$x^3-4x^2+8x^2-32x-3x^2+12x-24x+96$ or $x^3+4x^2-32x-3x^2-12x+96$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and -3
	$x^3+x^2-44x+96$	A1	
	Additional Guidance		
	Do not award A mark if further incorrect simplification or attempt to solve after correct answer seen		
	For method marks, terms may be given in a table with correct signs shown		