

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

GCSE MATHEMATICS

H

Higher Tier

Paper 2 Calculator

Thursday 7 June 2018

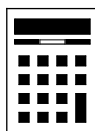
Morning

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.
- 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	
28–29	
TOTAL	

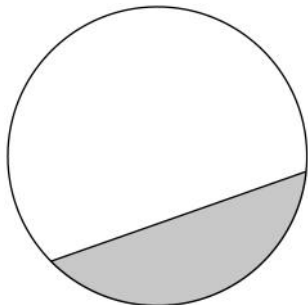


J U N 1 8 8 3 0 0 2 H 0 1

Answer **all** questions in the spaces provided

Do not write
outside the
box

- 1** Here is a circle.



Circle the word that describes the shaded part.

[1 mark]

segment

chord

sector

arc

- 2** Circle the number that is in standard form.

[1 mark]

$$0.25 \times 10^4$$

$$6 \times 10^7$$

$$38 \times 10^{-3}$$

$$4 \times 10^{\frac{1}{2}}$$



3 y is $1\frac{1}{2}$ times x .

Circle the ratio that is equivalent to $y : x$

[1 mark]

2 : 5

5 : 2

3 : 2

2 : 3

4 Work out 40 as a percentage of 10
Circle your answer.

[1 mark]

4%

25%

300%

400%

Turn over for the next question



- 5** Match each sequence to its description.
One has been done for you.

[4 marks]

1 1 2 3 5 8

Arithmetic progression

1 2 4 8 16 32

Geometric progression

1 2 3 4 5 6

Fibonacci sequence

1 3 6 10 15 21

Triangular numbers

1 4 9 16 25 36

Cube numbers

1 8 27 64 125 216

Square numbers



6

The table shows information about the population of a city.

Population in 2001	Population in 2011
420 000	480 000

Liam claims,

“From 2011 to 2021 the population of the city will increase by the same percentage as from 2001 to 2011”

He works out,

$$\begin{aligned}\text{population increase from 2001 to 2011} &= 480\,000 - 420\,000 \\ &= 60\,000\end{aligned}$$

$$\begin{aligned}\text{population in 2021} &= 480\,000 + 60\,000 \\ &= 540\,000\end{aligned}$$

Does the population of 540 000 match his claim?

You **must** show your working.

[3 marks]

Answer _____

Turn over for the next question



- 7** On three days, Ali throws darts at a target.
Here are his results.

	Number of throws	Number of hits	Number of misses
Monday	20	15	5
Tuesday	30	22	8
Wednesday	40	17	23
Total	90	54	36

- 7 (a)** Work out **two** different estimates for the probability of Ali hitting the target.

[2 marks]

Answer _____ and _____

- 7 (b)** Which of your two answers is the better estimate for the probability of Ali hitting the target?

Give a reason for your answer.

[1 mark]

Answer _____

Reason _____



8

Theo starts with savings of £18
James starts with no savings.

Each week from now,

Theo will save £4.50 and James will save £4

In how many weeks will Theo and James have savings in the ratio 15 : 8 ?

[3 marks]

Answer _____



9 The length of each side of a regular pentagon is 8.4 cm to 1 decimal place.

9 (a) Complete the error interval for the length of one side.

[2 marks]

_____ cm \leq length < _____ cm

9 (b) Complete the error interval for the perimeter.

[1 mark]

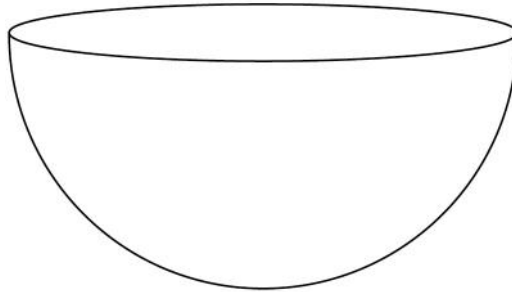
_____ cm \leq perimeter < _____ cm



10

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

A container is a hemisphere of radius 30 cm



Sand fills the container at a rate of 4000 cm^3 per minute.

Does it take **less than** a quarter of an hour to fill the container?

You **must** show your working.

[3 marks]

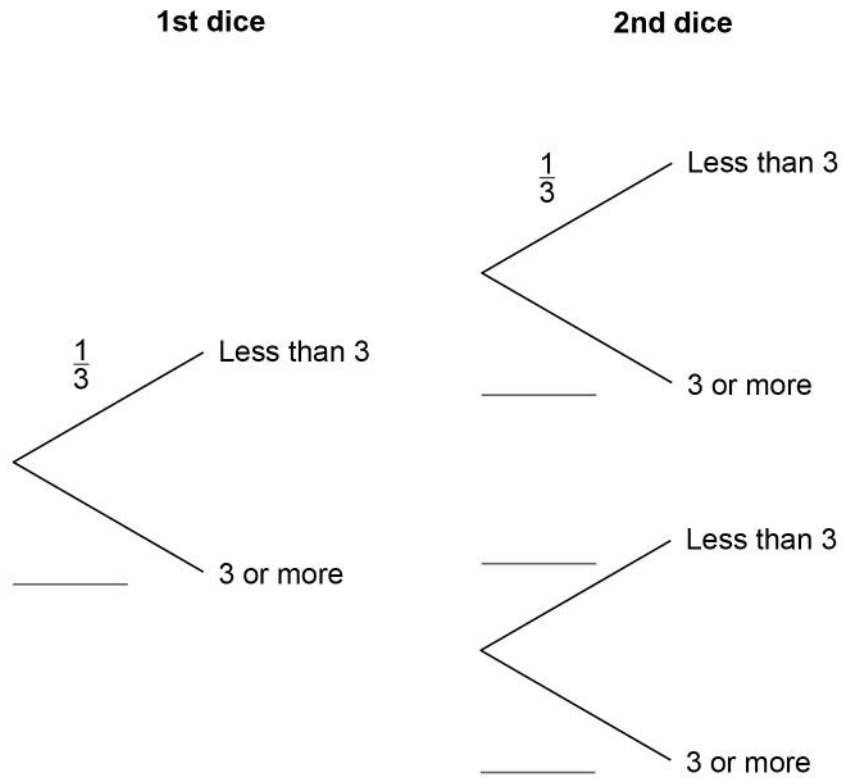
Answer _____



11 Two ordinary fair dice are rolled.

11 (a) Complete the tree diagram.

[1 mark]



11 (b) Work out the probability that **both** dice land on a number less than 3

[1 mark]

Answer _____



- 11 (c)** Work out the probability that **exactly one** of the dice lands on a number less than 3

[2 marks]

Answer _____

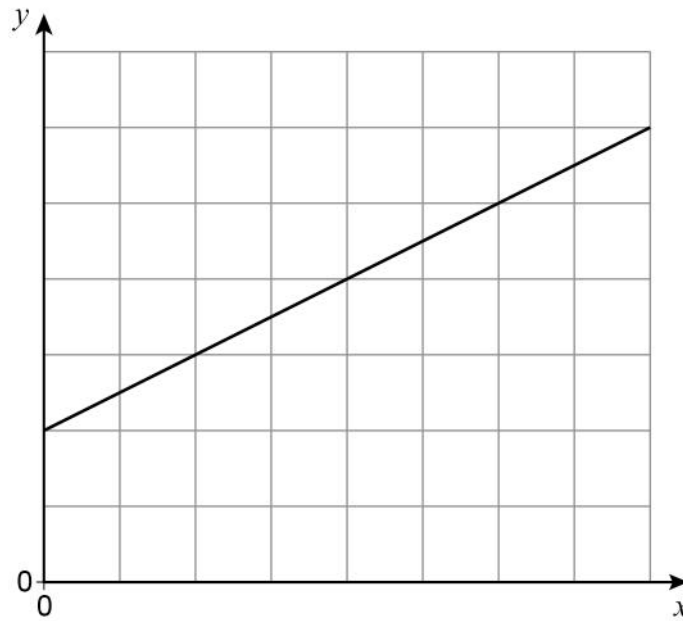
Turn over for the next question

4

Turn over ►



- 12** A straight line is drawn on the centimetre grid.



Fay assumes that the scale is 1 cm represents 1 unit.

- 12 (a)** Use her assumption to work out the gradient of the line.

[1 mark]

Answer _____



12 (b) In fact, the scale is 1 cm represents 2 units.

Which statement is correct?

Tick **one** box.

[1 mark]

☐

The answer to part (a) is too big

☐

The answer to part (a) stays the same

☐

The answer to part (a) is too small

Turn over for the next question



13

Show that, for $x \neq -1$ $\frac{8x^2 - 8}{4x + 4}$ simplifies to the form $ax + b$ where a and b are integers.**[3 marks]**



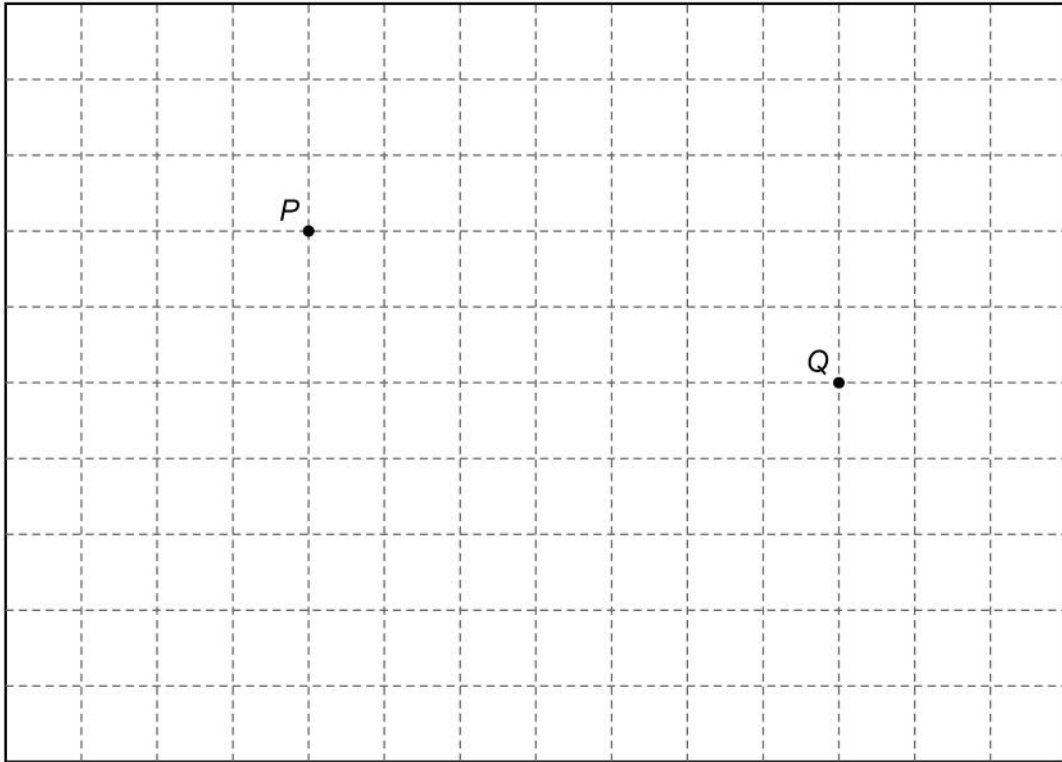
14

The scale drawing represents a garden.

Water from a sprinkler at P reaches up to 20 metres from P .

Water from a sprinkler at Q reaches up to 25 metres from Q .

Scale: 1 cm represents 5 m



Using a pair of compasses,

show the region that water from **both** sprinklers reaches.

[2 marks]

Turn over for the next question



- 15 100 men and 100 women took a test.

Scores

	Median	Interquartile range	Range
Men	28	7.5	31
Women	30	9	37

Using this data, which statement **must** be true?

Tick **one** box.

[1 mark]

☐

Men had a higher average score than women

☐

Men had more consistent scores than women

☐

A woman had the highest score

☐

A man had the lowest score



16 Some concrete has volume 3.8 m^3

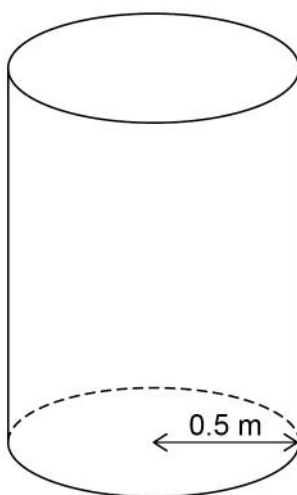
16 (a) The density of the concrete is 2400 kg/m^3

Work out the mass of the concrete.

[2 marks]

Answer _____ kg

16 (b) The 3.8 m^3 of concrete is made into the shape of a cylinder.
The base has radius 0.5 metres.



Work out the height of the cylinder.

[2 marks]

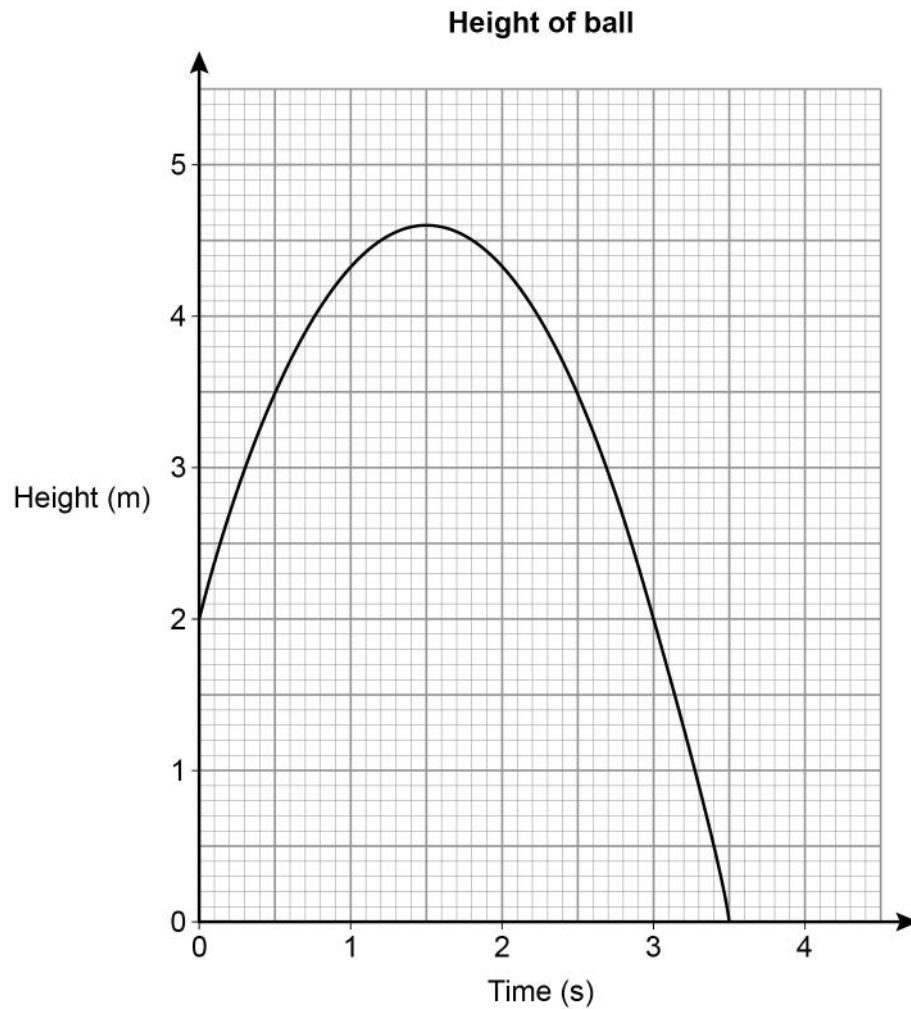
Answer _____ m



17

A ball is thrown vertically upwards.

The graph shows the height of the ball above the ground after it is thrown.



- 17 (a) For how many seconds is the ball at a height of **more than** 2 metres?

[1 mark]

Answer _____ s

- 17 (b) After how many seconds is the ball at instantaneous rest when it is in the air?

[1 mark]

Answer _____ s



- 17 (c) Work out the average speed of the ball when it is moving downwards.

[2 marks]

Answer _____ m/s

- 18 The solution of $3^x = 300$ lies between two consecutive integers.
Work out the two integers.

[1 mark]

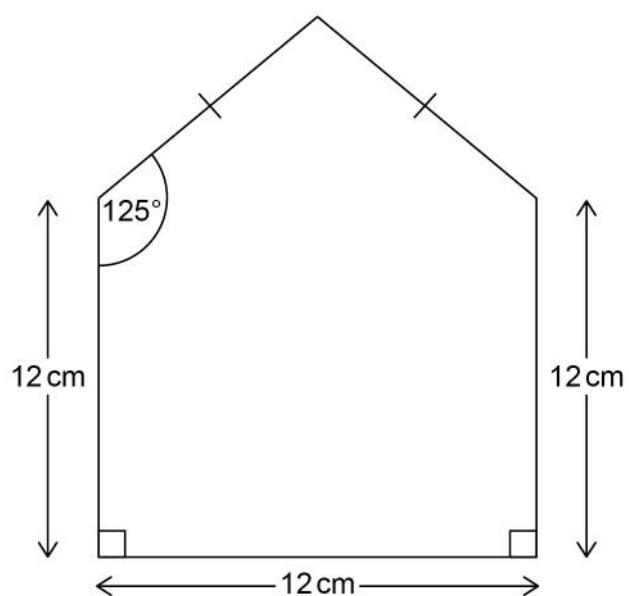
Answer _____ and _____

Turn over for the next question



19

A pentagon is made from a square and an isosceles triangle.



Not drawn
accurately

Work out the perimeter of the pentagon.

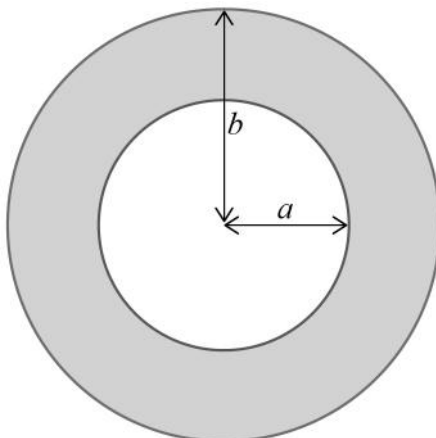
[4 marks]

Answer _____ cm



20

Here is an inflated swimming ring with dimensions in centimetres.



The volume of the ring, $V \text{ cm}^3$, is given by

$$V = 0.25\pi^2(b - a)^2(b + a)$$

Work out the volume when $a = 20$ and $b = 30$

Give your answer to 3 significant figures.

[3 marks]

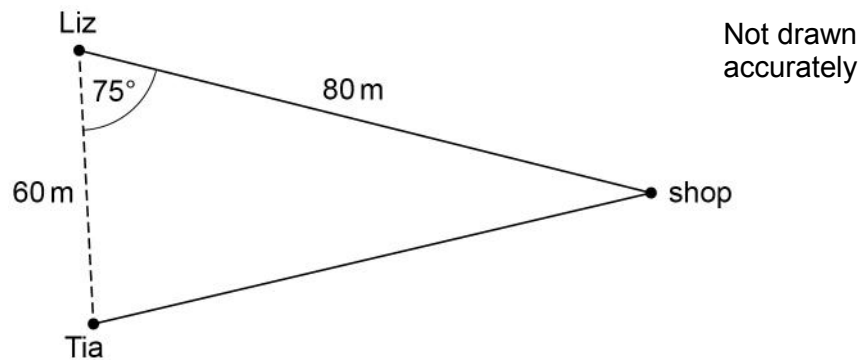
Answer _____ cm^3

Turn over for the next question

Turn over ►



- 21** Liz and Tia are walking towards a shop along different straight paths.
The diagram shows their positions at 2 pm



- 21 (a)** Assume they walk at the same speed.

Who will arrive at the shop first?

You **must** show your working.

[3 marks]

Answer _____

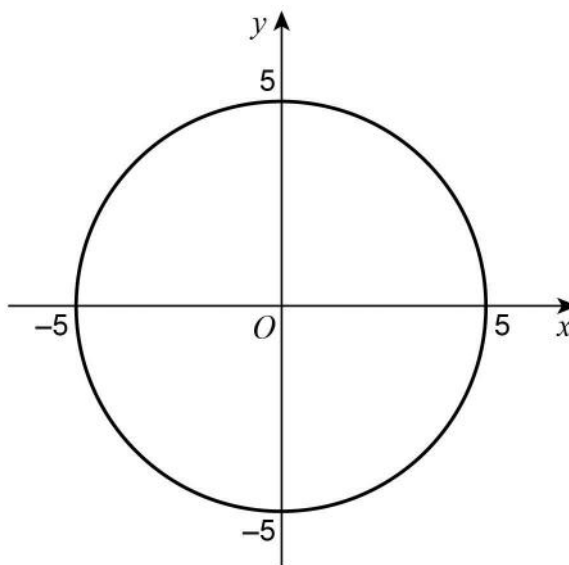
- 21 (b)** In fact, Liz walks at a faster speed than Tia.

How does this affect the answer to part (a)?

[1 mark]



- 22 A circle, centre O , passes through $(5, 0)$.



What is the equation of the circle?

Circle your answer.

[1 mark]

$x^2 + y^2 = 25$

$x^2 + y^2 = 5$

$x^2 + y^2 = 10$

$x^2 + y^2 = 100$

Turn over for the next question

Turn over ►



23

Solids X and Y are similar.

X has volume 64 cm^3 Y has volume 343 cm^3 The surface area of X is 176 cm^2

Work out the surface area of Y.

[3 marks]

Answer _____ cm^2 

24

A tank is a cuboid measuring 50 cm by 35 cm by 20 cm

All lengths are to the **nearest centimetre**.

A container has a capacity of **exactly** 34 litres.

1 litre = 1000 cm^3

Which has the greater capacity?

Tick **one** box.

☐

Tank

☐

Container

☐

Cannot tell

Show working to support your answer.

[4 marks]

Turn over for the next question



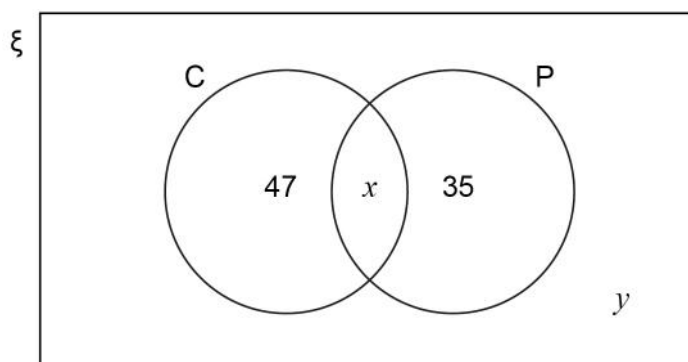
25

The Venn diagram shows some information about 150 students.

ξ = 150 students

C = students who study Chemistry

P = students who study Physics



The probability that a Physics student, chosen at random, also studies Chemistry is $\frac{5}{12}$

One of the 150 students is chosen at random.

Work out the probability that the student does **not** study either Chemistry or Physics.

[4 marks]

Answer _____



26

A curve has equation $y = 4x^2 + 5x + 3$

A line has equation $y = x + 2$

Show that the curve and the line have **exactly** one point of intersection.

Do **not** use a graphical method.

[4 marks]

Turn over for the next question



27

Prove algebraically that $2.\dot{7}\dot{5}$ converts to the fraction $\frac{124}{45}$

[3 marks]



28 $f(x) = 5 - x$ and $g(x) = 3x + 7$

28 (a) Simplify $f(2x) + g(x - 1)$

[3 marks]

Answer _____

28 (b) Solve $g^{-1}(x) = 2x$

[3 marks]

$x =$ _____

END OF QUESTIONS



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GCSE Mathematics

8300/2 – Paper 2 Higher Tier
Mark scheme

June 2018

Version/Stage: 1.0 Final

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 Assessment Writer.

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 $a \leq \text{value} < b$
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.

Question	Answer	Mark	Comments
1	segment	B1	
	Additional Guidance		
2	6×10^7	B1	
	Additional Guidance		
3	3 : 2	B1	
	Additional Guidance		
4	400%	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
5	All 5 correct	B4	B3 for 4 correct B2 for 3 correct B1 for 1 or 2 correct
	Additional Guidance		
			B4
	Two connections from a LH box is choice so is incorrect for that box		
	Connections do not have to be straight lines		

Question	Answer	Mark	Comments
6	Alternative method 1		
	Any one of $60\,000 \div 420\,000$ or $0.14\dots$ or $14.(...)\%$ or $\frac{1}{7}$ or $480\,000 \div 420\,000$ or $1.14\dots$ or $114.(...)\%$ or $\frac{8}{7}$ or $420\,000 \div 60\,000$ or 7 or $420\,000 \div 480\,000$ or 0.875 or 87.5% or $\frac{7}{8}$ or $60\,000 \div 540\,000$ or $0.11\dots$ or $11.(...)\%$ or $\frac{1}{9}$ or $540\,000 \div 60\,000$ or 9	M1	oe eg $60\,000 : 420\,000$ or $1 : 7$ or $480\,000 : 420\,000$ or $8 : 7$
	Any one of $60\,000 \div 480\,000$ or 0.125 or 12.5% or $\frac{1}{8}$ or $540\,000 \div 480\,000$ or 1.125 or 112.5% or $\frac{9}{8}$ or $480\,000 \div 60\,000$ or 8 or $480\,000 \div 540\,000$ or $0.88\dots$ or 0.89 or $88.(...)\%$ or 89% or $\frac{8}{9}$	M1	must be a matching pair (could be different forms) to award M2 (see A1 for list of matching pairs) oe eg $60\,000 : 480\,000$ or $1 : 8$ or $540\,000 : 480\,000$ or $9 : 8$

Mark scheme continues on the next page

Question	Answer	Mark	Comments
6 cont	$\frac{1}{7}$ and $\frac{1}{8}$ and No or $\frac{8}{7}$ and $\frac{9}{8}$ and No or 0.14... and 0.125 and No or 14.(...)% and 12.5% and No or 1.14... and 1.125 and No or 114.(...)% and 112.5% and No or 7 and 8 and No or $\frac{7}{8}$ and $\frac{8}{9}$ and No or $\frac{1}{9}$ and $\frac{1}{8}$ and No or 9 and 8 and No or 0.11... and 0.125 and No or 11.(...)% and 12.5% and No or 0.875 and 0.88... or 0.89 and No or 87.5% and 88.(...)% or 89% and No	A1	oe eg 1 : 7 and 1 : 8 and No

Mark scheme continues on the next page

Question	Answer	Mark	Comments
6 cont	Alternative method 2		
	<p>No and any one of</p> $\frac{60\,000}{420\,000} \times 480\,000 \text{ and}$ <p>[67200, 68640]</p> <p>or</p> $\frac{60\,000}{480\,000} \times 540\,000 \text{ and } 67\,500$ <p>or</p> $\frac{60\,000}{480\,000} \times 420\,000 \text{ and } 52\,500$ <p>or</p> $\frac{60\,000}{540\,000} \times 480\,000 \text{ and}$ <p>[52 800, 53 334]</p> <p>or</p> $\frac{420\,000}{480\,000} \times 540\,000 \text{ and } 472\,500$ <p>or</p> $\frac{480\,000}{420\,000} \times 480\,000 \text{ and}$ <p>[547 200, 548 640]</p> <p>or</p> $\frac{480\,000}{540\,000} \times 480\,000 \text{ and}$ <p>[422 400, 427 200]</p> <p>or</p> $\frac{540\,000}{480\,000} \times 420\,000 \text{ and } 472\,500$	B3	<p>oe</p> <p>B2 any one of the calculations</p> <p>B1 any one of the fractions oe</p> <p>for equivalent fractions, decimals and percentages see Alternative method 1</p>

Additional guidance continues on the next page

Question	Answer	Mark	Comments
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6 cont	Additional Guidance		
	In Alt 1, for M2 the matching pair do not have to be in comparable form eg 14.3% and $\frac{1}{8}$ and No		M1M1A0
	For comparable fractions, they must be in their lowest terms or have the same numerators or the same denominators for the A1 eg Alt 1 $\frac{60\,000}{420\,000}$ and $\frac{60\,000}{480\,000}$ and No		M1M1A1
	For comparable ratios, they must be in their lowest terms or have the same LH sides or the same RH sides for the A1 eg Alt 1 60 000 : 420 000 and 60 000 : 480 000 and No		M1M1A1
	If working with percentages, condone absence of % symbol eg Alt 1 14 and 12.5 and No		M1M1A1
	Both are increases of 60 000 and it is then over different amounts so cannot be the same percentage		M0M0A0

Question	Answer	Mark	Comments
7(a)	<p>Two different probabilities from</p> <p>$\frac{15}{20}$ or 0.75 or 75%</p> <p>or</p> <p>$\frac{22}{30}$ or 0.73... or 73.(...)%</p> <p>or</p> <p>$\frac{17}{40}$ or 0.425 or 0.43</p> <p>or 42.5% or 43%</p> <p>or</p> <p>$\frac{54}{90}$ or 0.6 or 60%</p> <p>or</p> <p>$\frac{37}{50}$ or 0.74 or 74%</p> <p>or</p> <p>$\frac{32}{60}$ or 0.53... or 53.(...)%</p> <p>or</p> <p>$\frac{39}{70}$ or 0.557... or 0.56</p> <p>or 55.7...% or 56%</p>	B2	<p>oe</p> <p>B1 for one correct probability</p>

Additional guidance continues on the next page

Question	Answer	Mark	Comments
7(a) cont	Additional Guidance		
	Accept $\frac{108}{180}$ as one of the probabilities		
	Mark the answer line if it has two answers ignoring any incorrect probabilities in the working lines		
	Ignore any incorrect cancelling or change of form (fraction, decimal or percentage)		
	If the answer line only has one answer, check the working lines for a second answer for B2. Ignore any extra probabilities, unless incorrect, in which case award B1 max eg Working lines $\frac{15}{20}$ Answer line $\frac{54}{90}$		B2
	eg Working lines $\frac{15}{20}, \frac{5}{15}$ Answer line $\frac{54}{90}$		B1
	If the answer line is blank, check the working lines for answers for B1 or B2. Ignore any extra probabilities, unless incorrect, in which case award B1 max eg Working lines $\frac{15}{20}, \frac{22}{30}, \frac{54}{90}$ Answer line blank		B2
	eg Working lines $\frac{15}{20}, \frac{5}{15}, \frac{54}{90}$ Answer line blank		B1
	Probabilities must not be given as ratios		
	Do not accept the average of the given probabilities as answer		

Question	Answer	Mark	Comments
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7(b)	Alternative method 1 (ft their part (a))		
	Their probability with the greater number of trials and valid reason eg More throws	B1ft	ft their two different probabilities from part (a) both probabilities must have a denominator based on throws
	Alternative method 2 (independent of part (a))		
	$\frac{54}{90}$ and valid reason eg Total throws	B1	oe
	Additional Guidance		
	Accept any unambiguous indication of their probability eg the day		
	Using ratios		B0
	Ignore any non-contradictory statements		
	60% and It's for all three days		B1
	$\frac{54}{90}$ and It takes into account more throws		B1
	$\frac{17}{40}$ (with $\frac{22}{30}$ also in (a)) and Because he threw it more on Wednesday		B1ft
	$\frac{54}{90}$ and Shows the overall probability		B1
	$\frac{54}{90}$ and Probability over total throws		B1
	$\frac{54}{90}$ (with Wednesday probability in (a)) and It's the average total days, not just Wednesdays		B1ft

Additional guidance continues on the next page

Question	Answer	Mark	Comments
7(b) cont	Correct ft probability or $\frac{54}{90}$ and It's more reliable		B0
	$\frac{54}{90}$ and There's a lot of data		B0
	Correct ft probability or $\frac{54}{90}$ and He may get better with more throws		B0
	$\frac{54}{90}$ and He throws 90 times		B0
	Correct ft probability or $\frac{54}{90}$ and More hits		B0
8	Alternative method 1		
	22.5(0) and 4 or 27 and 8 or 31.5(0) and 12 or 36 and 16 or 40.5(0) and 20 or 45 and 24 or 30 : 16 or 45 : 24	M1	
	45 and 24 chosen	A1	eg 45 : 24 is the final ratio seen
	6	A1	

Mark scheme and additional guidance continues on the next page

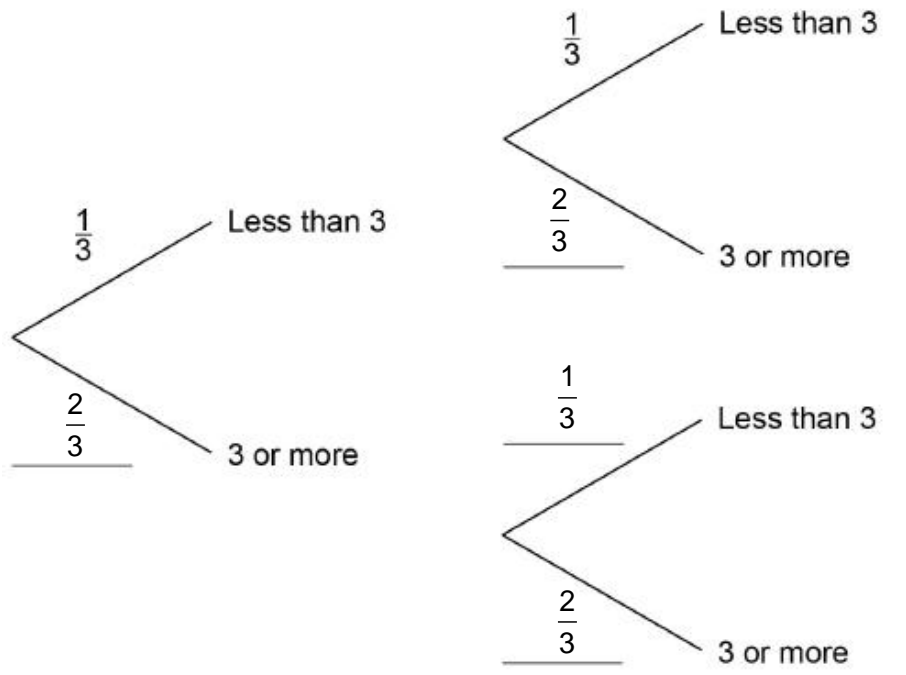
Question	Answer	Mark	Comments
8 cont	Alternative method 2		
	$18 + 4.5x$ and $4x$ seen or $\frac{18 + 4.5x}{15} = \frac{4x}{8}$	M1	any letter oe sets up correct equation
	$8(18 + 4.5x) = 60x$ or $144 + 36x = 60x$ or $24x = 144$	M1dep	eliminates denominators oe
	6	A1	
	Additional Guidance		
	Answer 6 that is not from incorrect method		M1A1A1
	45 and 24 followed by eg 49.5(0) and 28 (answer not 6)		M1A0A0
	Equivalent ratio to 15 : 8 that is not 30 : 16 or 45 : 24 eg 60 : 32 (answer not 6)		M0A0A0
	Final calculation $\frac{15}{8} \times 24 = 45$ (answer not 6)		M1A1A0

Question	Answer	Mark	Comments
9(a)	8.35 and 8.45 in the correct order	B2	B1 8.35 on the left or 8.45 on the right or 8.45 and 8.35 in the wrong order accept $8.44\dot{9}$ for 8.45
	Additional Guidance		
	Do not accept 8.449... for $8.44\dot{9}$		
9(b)	41.75 and 42.25	B1ft	correct or ft their two different values from (a) their 8.35 must be in the range (8.3, 8.4] their 8.45 must be in the range (8.4, 8.5] correct order or ft order accept $42.24\dot{9}$ for 42.25
	Additional Guidance		
	(8.3, 8.4] does not include 8.3 but does include 8.4 (8.4, 8.5] does not include 8.4 but does include 8.5		
	Answer of 8.35 and 8.44 in part (a) leading to 41.75 and 42.2		B1ft
	Answer of 8 and 9 in part (a) leading to 40 and 45		B0ft

Question	Answer	Mark	Comments
10	Alternative method 1		
	$\frac{4}{3}\pi \times 30^3$ or $36\,000\pi$ or [112 757, 113 112] or $\frac{1}{2} \times \frac{4}{3}\pi \times 30^3$ or $18\,000\pi$ or [55 954, 56 839]	M1	oe allow 1.33... for $\frac{4}{3}$ allow 0.66... or 0.67 for $\frac{2}{3}$
	their [112 757, 113 112] $\div 4000$ or 9π or 28.(...) or their [55 954, 56 839] $\div 4000$ or $\frac{9\pi}{2}$ or [13.9, 14.21] or their [112 757, 113 112] $\div (4000 \times 60)$ or $\frac{3\pi}{20}$ or [0.46, 0.4713] or their [55 954, 56 839] $\div (4000 \times 60)$ or $\frac{3\pi}{40}$ or 0.23... or 0.24	M1dep	
	[13.9, 14.21] and Yes or 0.23... or 0.24 and Yes	A1	

Mark scheme and additional guidance continues on the next page

Question	Answer	Mark	Comments
10 cont	Alternative method 2		
	$\frac{4}{3}\pi \times 30^3$ or $36\,000\pi$ or [112 757, 113 112] or $\frac{1}{2} \times \frac{4}{3}\pi \times 30^3$ or $18\,000\pi$ or [55 954, 56 839]	M1	oe allow 1.33... for $\frac{4}{3}$ allow 0.66... or 0.67 for $\frac{2}{3}$
	4000×15 or $60\,000$	M1	
	[55 954, 56 839] and $60\,000$ and Yes	A1	
	Alternative method 3		
	$\frac{4}{3}\pi \times 30^3$ or $36\,000\pi$ or [112 757, 113 112] or $\frac{1}{2} \times \frac{4}{3}\pi \times 30^3$ or $18\,000\pi$ or [55 954, 56 839]	M1	oe allow 1.33... for $\frac{4}{3}$ allow 0.66... or 0.67 for $\frac{2}{3}$
	their [112 757, 113 112] $\div 15$ or 2400π or [7517, 7541] or their [55 954, 56 839] $\div 15$ or 1200π or [3730, 3790]	M1dep	
	[3730, 3790] and Yes	A1	
	Additional guidance		
	Do not award A1 if incorrect conversion of $\frac{1}{4}$ hour seen		

Question	Answer	Mark	Comments
11(a)	$\frac{1}{3}$ or $\frac{2}{6}$ or 0.33... or 33.(...)% on each top branch and $\frac{2}{3}$ or $\frac{4}{6}$ or 0.66... or 0.67 or 66.(...)% or 67% on each bottom branch	B1	accept any equivalent fraction, decimal or percentage
	Additional Guidance		
	Decimals must have at least 2 decimal places so do not accept 0.3 or 0.6 or 0.7		
	Only accept the percentages shown, do not accept 30% or 60%		
	Ignore working around the edge of the diagram		
			B1

Question	Answer	Mark	Comments
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11(b)	$\frac{1}{9}$ or 0.11... or 11.(...)%	B1	
	Additional Guidance		
	Ignore probability words such as 'unlikely' or 'evens'		
	Accept equivalent answers eg $\frac{2}{18}$, $\frac{3}{27}$, 0.1		
	Do not accept 0.1 or 10%		

11(c)	Alternative method 1 Probabilities on branches in (a) all correct		
	$\frac{1}{3} \times \frac{2}{3}$ or $\frac{2}{3} \times \frac{1}{3}$ or $\frac{2}{9}$	M1	oe accept 0.33... for $\frac{1}{3}$ accept 0.66... or 0.67 for $\frac{2}{3}$
	$\frac{4}{9}$ or 0.44... or 44.(...)%	A1	
	Alternative method 2 Probabilities on branches in (a) all correct		
	$1 - (\frac{1}{3} \times \frac{1}{3}) - (\frac{2}{3} \times \frac{2}{3})$	M1	oe accept 0.33... for $\frac{1}{3}$ accept 0.66... or 0.67 for $\frac{2}{3}$
	$\frac{4}{9}$ or 0.44... or 44.(...)%	A1	

Mark scheme continues on the next page

Question	Answer	Mark	Comments
11(c) cont	Alternative method 3 Probabilities on branches in (a) not all correct		
	$\frac{1}{3} \times \text{their } \frac{2}{3}$ where their $\frac{2}{3}$ must be for 2nd dice 3 or more or $\text{their } \frac{2}{3} \times \text{their } \frac{1}{3}$ where their $\frac{2}{3}$ must be for 1st dice 3 or more and their $\frac{1}{3}$ must be for 2nd dice less than 3	M1	oe accept 0.33... for $\frac{1}{3}$ accept 0.66... or 0.67 for $\frac{2}{3}$ their fractions must be between 0 and 1
	$\frac{4}{9}$ or 0.44... or 44.(...)%	A1ft	ft their fractions
	Alternative method 4 Probabilities on branches in (a) not all correct		
	$1 - \left(\frac{1}{3} \times \frac{1}{3}\right) - \left(\text{their } \frac{2}{3} \times \text{their } \frac{2}{3}\right)$ where their $\frac{2}{3}$ must be for 1st dice 3 or more and their $\frac{2}{3}$ must be for 2nd dice 3 or more	M1	accept 0.33... for $\frac{1}{3}$ accept 0.66... or 0.67 for $\frac{2}{3}$ their fractions must be between 0 and 1
	$\frac{4}{9}$ or 0.44... or 44.(...)%	A1ft	ft their fractions

Additional guidance continues on the next page

Question	Answer	Mark	Comments
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11(c) cont	Additional Guidance		
	If probabilities on branches in (a) are all $\frac{1}{3}$		M0A0
	Decimals must have at least 2 decimal places so do not accept 0.3 or 0.6 or 0.7		
	Ignore any incorrect cancelling or change of form (fraction, decimal or percentage)		
	$\frac{1}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{1}{3}$		M0A0
	$\frac{1}{3} \times \frac{2}{3}$ and $\frac{1}{3} \times \frac{1}{3}$ without selecting $\frac{1}{3} \times \frac{2}{3}$ is choice		M0

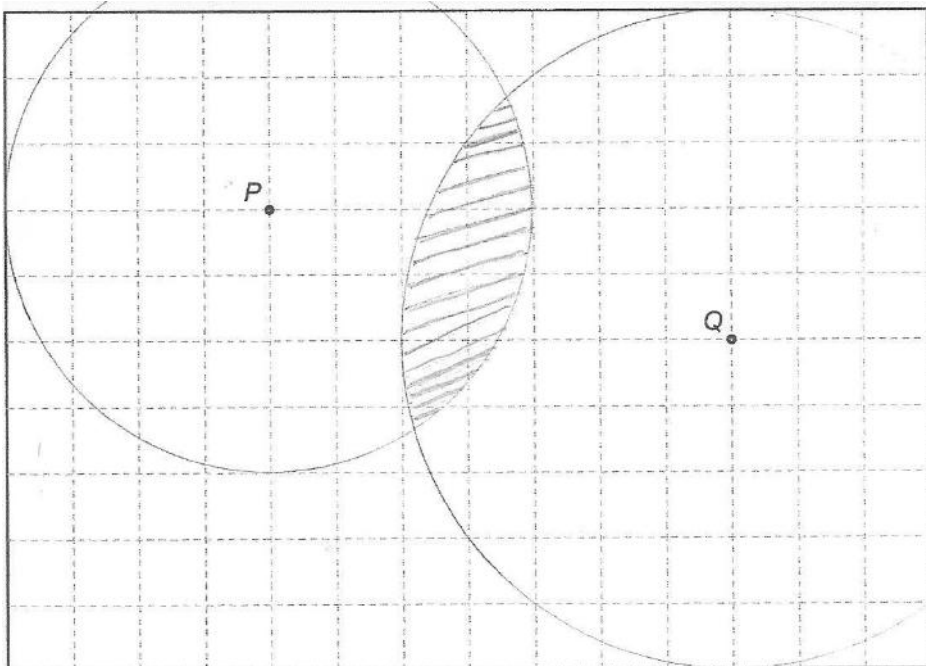
12(a)	$\frac{1}{2}$ or 0.5	B1	oe eg $\frac{4}{8}$ or $\frac{2}{4}$
	Additional Guidance		
	1 : 2 or 50%		B0
	$\frac{1}{2}x$		B0
	$y = 0.5x + 2$		B0
	$\frac{0.5}{1}$		B0
	Ignore units		

Question	Answer	Mark	Comments
12(b)	<div><input type="checkbox"/> The answer to part (a) is too big</div> <div><input checked="" type="checkbox"/> The answer to part (a) stays the same</div> <div><input type="checkbox"/> The answer to part (a) is too small</div>	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
13	Alternative method 1		
	Any correct factorisation of the numerator or the denominator	M1	eg $8(x^2 - 1)$ or $4(x + 1)$ or $2(4x^2 - 4)$ or $2(2x + 2)$ or $4(2x^2 - 2)$ or $(4x + 4)(2x - 2)$ or $(4x - 4)(2x + 2)$ or $(8x + 8)(x - 1)$ or $(8x - 8)(x + 1)$ or $-2(-4x^2 + 4)$ does not need to be seen in a fraction may be implied eg $\frac{2x^2 - 2}{x + 1}$ or $\frac{4x^2 - 4}{2x + 2}$
	Correct fraction with a common algebraic factor in the numerator and the denominator	A1	eg $\frac{8(x + 1)(x - 1)}{4(x + 1)}$ or $\frac{2(2x + 2)(2x - 2)}{2(2x + 2)}$ or $\frac{2(x + 1)(x - 1)}{(x + 1)}$ or $\frac{4(x + 1)(2x - 2)}{4(x + 1)}$ or $\frac{(4x + 4)(2x - 2)}{4x + 4}$
	$2x - 2$ or $a = 2$ and $b = -2$ with M1A1 scored	A1	

Mark scheme and additional guidance continues on the next page

Question	Answer	Mark	Comments
13 cont	Alternative method 2		
	$4ax^2 + 4ax + 4bx + 4b$	M1	oe expands $(ax + b)(4x + 4)$ to 4 terms with at least 3 terms correct
	Any 2 of $4a = 8$ $4b = -8$ $4a + 4b = 0$	A1	
	$a = 2$ and $b = -2$ and shows that third equation is satisfied with M1A1 scored	A1	
	Additional Guidance		
	M1 is implied by the first A1 eg $\frac{8(x+1)(x-1)}{4(x+1)}$	M1A1	
	$1(8x^2 - 8)$ or $-1(8 - 8x^2)$ etc	M0	
	$2x - 2$ without M1A1 scored	M0A0A0	
	M1A1 scored and $2x - 2$ followed by attempt to solve $2x - 2 = 0$	M1A1A1	
	M1A1 scored and $2x - 2$ followed by $2(x - 1)$	M1A1A1	
	M1A1 scored followed by $2(x - 1)$ but $2x - 2$ not seen	M1A1A0	

Question	Answer	Mark	Comments
14	Arc radius [3.8, 4.2] cm centre P or arc radius [4.8, 5.2] cm centre Q	M1	only need arcs within tolerance for the correct region ignore other lines M1 arc radius [3.8, 4.2] cm centre Q and arc radius [4.8, 5.2] cm centre P and correct ft region identified
	Arc radius [3.8, 4.2] cm centre P and arc radius [4.8, 5.2] cm centre Q and region identified	A1	only need arcs within tolerance for the correct region ignore other lines
	Additional Guidance		
	Arcs may go outside the rectangle		
	Allow any unambiguous indication of the region eg labelled R or appropriate shading		
	Do not accept highlighting the perimeter of the region for identification of the region		
			M1A1

Question	Answer	Mark	Comments
15	Men had more consistent scores than women	B1	
	Additional Guidance		
16(a)	2400×3.8 or $\frac{m}{3.8} = 2400$ or $\frac{m}{2400} = 3.8$	M1	oe equation allow mass for m allow any letter apart from v or d
	9120	A1	
	Additional Guidance		
16(b)	$\pi r^2 h = 3.8$ or $\pi \times 0.5^2 \times h$ or $0.25\pi h$ or $[0.78, 0.79]h$ or $3.8 \div (\pi \times 0.5^2)$ or $3.8 \div 0.25\pi$ or $3.8 \div [0.78, 0.79]$	M1	oe eg $\pi r^2 = \frac{3.8}{h}$
	[4.8, 4.841]	A1	
	Additional Guidance		
	$\pi 0.5^2 h$		M1

Question	Answer	Mark	Comments
17(a)	[2.9, 3]	B1	
	Additional Guidance		
17(b)	[1.4, 1.6]	B1	
	Additional Guidance		
17(c)	$\frac{[4.55, 4.65] - 0}{3.5 - [1.5, 1.6]}$ or $\frac{[4.55, 4.65]}{[1.9, 2]}$ or $\frac{[4.55, 4.65] - 0}{[1.5, 1.6] - 3.5}$ or $\frac{[4.55, 4.65]}{[-2, -1.9]}$ or $[-2.45, -2.275]$	M1	oe
	[2.275, 2.45]	A1	
	Additional Guidance		
18	5 and 6 with no incorrect evaluation seen for 3^5 or 3^6 or 5 and 6 with no incorrect evaluation seen for $\sqrt[5]{300}$ or $\sqrt[6]{300}$	B1	5 and 6 in either order allow any evaluations truncated or rounded to 2 sf or 1 sf
	Additional Guidance		
	5 and 6 with either 3^5 or 3^6 evaluated incorrectly		B0
	3^5 or 3^6		B0
	243 and 729		B0
	$3^5 = 243$ Allow 240 or 200 (with no incorrect value seen) $3^6 = 729$ Allow 720 or 730 or 700 (with no incorrect value seen)		
	$\sqrt[5]{300} = 3.1(2\dots)$ or 3.13 $\sqrt[6]{300} = 2.5(8\dots)$ or 2.59 or 2.6		

Question	Answer	Mark	Comments
19	Alternative method 1 Using one half of the isosceles triangle		
	(base angle =) 35 or (top angle =) 55	B1	may be on diagram
	$\cos(\text{their } 35) = \frac{6}{x}$ or $\sin(\text{their } 55) = \frac{6}{x}$ or $6^2 + (6 \tan(\text{their } 35))^2$	M1	oe eg $\frac{\sin 90}{x} = \frac{\sin(\text{their } 55)}{6}$ any letter their 35 must be acute their 55 must be acute
	$\frac{6}{\cos(\text{their } 35)}$ or $\frac{6}{\sin(\text{their } 55)}$ or $\sqrt{6^2 + (6 \tan(\text{their } 35))^2}$ or 7.3(2...)	M1dep	oe
	[50.6, 50.65]	A1ft	ft B0M2 with evaluation of $36 + 2 \times \text{their } 7.3(2...)$

Mark scheme and additional guidance continues on the next page

Question	Answer	Mark	Comments
19 cont	Alternative method 2 Using the isosceles triangle		
	(base angle =) 35 or (top angle =) 110	B1	may be on diagram
	$\frac{x}{\sin(\text{their } 35)} = \frac{12}{\sin(\text{their } 110)}$ or $12^2 = x^2 + x^2 - 2 \times x \times x \times \cos(\text{their } 110)$ or $x^2 = x^2 + 12^2 - 2 \times x \times 12 \times \cos(\text{their } 35)$	M1	oe any letter their 35 must be acute their 110 cannot be 125
	$\frac{12}{\sin(\text{their } 110)} \times \sin(\text{their } 35)$ or $\sqrt{\frac{12^2}{2 - 2 \cos(\text{their } 110)}}$ or $\frac{12^2}{2 \times 12 \times \cos(\text{their } 35)}$ or 7.3(2...)	M1dep	oe
	[50.6, 50.65]	A1ft	ft B0M2 with evaluation of 36 + 2 × their 7.3(2...)
	Additional Guidance		
	Allow B1 even if the angle is not subsequently used		
	Alt 2 Top angle 90		M0M0A0
	Answer [50.6, 50.65] (possibly from scale drawing)		B1M1M1A1

Question	Answer	Mark	Comments
20	$0.25\pi^2(30 - 20)^2(30 + 20)$ or $0.25\pi^2 \times 10^2 \times 50$	M1	oe allow use of π as [3.14, 3.142]
	[12 320, 12 340.21]	A1	may be implied
	12 300 or 1.23×10^4 with no value outside [12 320, 12 340.21] seen	A1	
	Additional Guidance		
	$0.25\pi^2(30 - 20)^2(30 + 20)$ 12 300	M1 A1(implied)A1	
	12 300 with no incorrect working	M1A1A1	
	12 300.0 is not to 3 significant figures		
	M1 gained followed by answer 12 300.0	M1A0A0	
	Do not allow misreads eg $0.25\pi^2(30 + 20)^2(30 + 20)$	M0A0A0	
	Brackets expanded correctly and values substituted	M1	

Question	Answer	Mark	Comments
21(a)	Alternative method 1		
	$80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$ or $6400 + 3600 - 9600 \cos 75$ or 7515.(...)	M1	oe
	$\sqrt{\text{their } 7515.(...)}$ or [86.6, 86.7] or 87	M1dep	
	[86.6, 86.7] and Liz or 87 and Liz	A1	accept 86 and Liz or 90 and Liz with full method seen
	Alternative method 2		
	$80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$ or $6400 + 3600 - 9600 \cos 75$ or 7515.(...)	M1	oe
	$(80^2 =) 6400$ and 7515.(...) and Liz	A2	
	Additional Guidance		
	$80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$ seen followed by processing error can score up to M2 eg $80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$ $= 6400 + 3600 - 9600 \cos 75$ $= 400 \cos 75 = 103.5$ $\sqrt{103.5}$	M1 M1depA0	
	You may need to check on your calculator whether to award M1dep after first M1 with a processing error seen eg $80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75 = 3654$ (processing error) 60.4 (square root of 3654 is implied)	M1 M1depA0	
	Ignore any reasons given		
	Alt 2 not possible to score M1A1		
	Answer [86.6, 86.7] and Liz (possibly from scale drawing)	M1M1A1	
	[86.6, 86.7] (possibly from scale drawing)	M1M1	

Question	Answer	Mark	Comments
21(b)	Alternative method 1 (answer Liz in (a))		
	No change	B1	oe eg Liz will still arrive first or Liz will be there even earlier (than Tia)
	Alternative method 2 (answer Tia in (a))		
	Not possible to tell	B1ft	oe eg Liz might arrive before Tia or it depends on how much faster Liz walks or it could be either of them
	Alternative method 3 (answer they arrive at same time in (a))		
	Liz will arrive first	B1ft	oe eg Liz wins
	Alternative method 4 (neither Liz or Tia in (a))		
	If Liz had arrived first there would be no change and if Tia had arrived first it would not be possible to tell	B1ft	oe
	Additional Guidance		
	If correct decision is made, ignore non-contradictory further work		
	Alt 1 Liz will arrive earlier		B1
	Alt 1 No		B0
	Alt 2 Yes		B0
22	$x^2 + y^2 = 25$	B1	
	Additional Guidance		

Question	Answer	Mark	Comments
23	$\sqrt[3]{64}$ and $\sqrt[3]{343}$ or 4 and 7 or $\sqrt[3]{[5.3, 5.4]}$ or [1.74, 1.754411] or $\sqrt[3]{[0.18, 0.19]}$ or [0.56, 0.575]	M1	oe eg 4 : 7 or 7 : 4 or $\sqrt[3]{\frac{343}{64}}$ or $\frac{7}{4}$ or $\sqrt[3]{\frac{64}{343}}$ or $\frac{4}{7}$
	their 4^2 and their 7^2 or 16 and 49 or their [1.74, 1.754411] ² or [3.02, 3.08] or their [0.56, 0.575] ² or [0.31, 0.331]	M1dep	oe eg 16 : 49 or 49 : 16 or $\left(\text{their } \frac{7}{4}\right)^2$ or $\frac{49}{16}$ or $\left(\text{their } \frac{4}{7}\right)^2$ or $\frac{16}{49}$
	539	A1	
	Additional Guidance		
	4^3 and 7^3		M1
	$64^{\frac{2}{3}}$ and $343^{\frac{2}{3}}$		M1M1
	$\left(\frac{343}{64}\right)^{\frac{2}{3}}$ or $\left(\frac{64}{343}\right)^{\frac{2}{3}}$		M1M1
	Answer 539 with evidence of rounding to 539 scores A0 eg1 $176 \times 3.06 = 538.56$ Answer 539 eg2 $176 \times 3.06 = 539$ (may have kept all digits on calculator)		M1M1A0 M1M1A1
	$\left(\sqrt{176} \times \frac{7}{4}\right)^2$		M1M1
	$176 \div 16 = 11$ and 11×49		M1M1
	4 and 7 (and/or 4^2 and 7^2) but uses different method not involving 4 and 7		M1M0A0

Question	Answer	Mark	Comments
24	Alternative method 1		
	Any product of three valid dimensions that would give a volume < 34 000 or any product of three valid dimensions that would give a volume > 34 000	M1	eg $49.5 \times 34.5 \times 19.5$ or $50.5 \times 35.5 \times 20.5$ or $50 \times 35 \times 20$ ignore any evaluations of products
	Any product of three valid dimensions that would give a volume < 34 000 and any product of three valid dimensions that would give a volume > 34 000	M1dep	eg $49.5 \times 34.5 \times 19.5$ and $50.5 \times 35.5 \times 20.5$ ignore any evaluations of products
	34×1000 or 34 000	M1	converts to cm^3
	their volume < 34 000 and their volume > 34 000 and 34 000 and ticks Cannot tell	A1	both volumes in cm^3 must see working for M3 answers for their volumes must be seen and be correct or rounded or truncated to at least 2 sf (unless 34 000 to 2 sf when must be to at least 3 sf)

Mark scheme continues on the next page

Question	Answer	Mark	Comments
24 cont	Alternative method 2		
	Any product of three valid dimensions that would give a volume < 34 000 or any product of three valid dimensions that would give a volume > 34 000	M1	eg $49.5 \times 34.5 \times 19.5$ or $50.5 \times 35.5 \times 20.5$ or $50 \times 35 \times 20$ ignore any evaluations of products
	Any product of three valid dimensions that would give a volume < 34 000 and any product of three valid dimensions that would give a volume > 34 000	M1dep	eg $49.5 \times 34.5 \times 19.5$ and $50.5 \times 35.5 \times 20.5$ ignore any evaluations of products
	one of their volumes $\div 1000$	M1dep	dep on first M1 converts to litres
	their volume < 34 and their volume > 34 and ticks Cannot tell	A1	both volumes in litres must see working for M3 answers for their volumes must be seen and be correct or rounded or truncated to at least 2 sf (unless 34 000 to 2 sf when must be to at least 3 sf)

Additional guidance continues on the next page

Question	Answer	Mark	Comments
24 cont	Additional Guidance		
	There are an infinite number of sets of three valid dimensions Valid dimensions for 50 are [49.5, 50.5] for 35 are [34.5, 35.5] for 20 are [19.5, 20.5]		
	49.5 × 34.5 × 19.5 = 33 301.(...) or 33 000 or 33 300 49.6 × 34.6 × 19.6 = [33 636, 33 637] or 33 000 or 33 600 or 33 630 or 33 640 49.7 × 34.7 × 19.7 = 33 974.(...) or 33 000 or 33 900 or 33 970 49.8 × 34.8 × 19.8 = 34 314.(...) or 34 300 or 34 310 49.9 × 34.9 × 19.9 = 34 656.(...) or 34 600 or 34 700 or 34 650 or 34 660 50 × 35 × 20 = 35 000 50.1 × 35.1 × 20.1 = 35 346.(...) or 35 000 or 35 300 or 35 340 or 35 350 50.2 × 35.2 × 20.2 = 35 694.(...) or 35 000 or 36 000 or 35 600 or 35 700 or 35 690 50.3 × 35.3 × 20.3 = 36 044.(...) or 36 000 or 36 040 50.4 × 35.4 × 20.4 = [36 396, 36 397] or 36 000 or 36 300 or 36 400 or 36 390 50.5 × 35.5 × 20.5 = 36 751.(...) or 36 000 or 37 000 or 36 700 or 36 800 or 36 750		
	Three valid dimensions do not have to follow a pattern eg 49.6 × 35 × 20.4 (= 35 414.(...) or 35 000 or 35 400 or 35 410)		M1
	49.5 34.5 19.5 and 33 301 (answer implies multiplication signs)		M1
	49.5 34.5 19.5 (no answer so multiplication signs not implied)		M0
	33 301 but 49.5 34.5 19.5 not seen		M0
	Units do not have to be seen		

Question	Answer	Mark	Comments
25	$\frac{x}{x+35} = \frac{5}{12}$ or $\frac{35}{x+35} = \frac{7}{12}$ or $\frac{x}{35} = \frac{5}{7}$ or $x : 35 = 5 : 7$ or links $\frac{7}{12}$ to 35	M1	oe eg $x + 35 = 60$ or links $\frac{1}{12}$ to 5
	$12x - 5x = 175$ or $7x = 175$ or $420 - 245 = 7x$ or $(x =) 25$ or $\frac{25}{60}$	M1dep	oe collects terms 25 may be seen in section labelled x on Venn diagram
	$(y =) 150 - 47 - 35 - \text{their } 25$ or 43	M1dep	dep on M2 43 may be seen in section labelled y on Venn diagram
	$\frac{43}{150}$ or 0.286... or 0.287 or 0.29 or 28.6...% or 28.7% or 29%	A1	
	Additional Guidance		
	Accept $\frac{7}{12} = 35$		M1
	Ignore any incorrect cancelling or change of form (fraction, decimal or percentage)		

Question	Answer	Mark	Comments
26	Alternative method 1		
	$4x^2 + 5x + 3 = x + 2$	M1	
	$4x^2 + 5x - x + 3 - 2 (= 0)$ or $4x^2 + 4x + 1 (= 0)$	M1dep	oe collection of terms eg $4x^2 + 5x - x = 2 - 3$ or $4x^2 + 4x = -1$
	$(2x + 1)(2x + 1) (= 0)$ or $4\left(x + \frac{1}{2}\right)^2 (= 0)$ or $\frac{-4 \pm \sqrt{4^2 - 4 \times 4 \times 1}}{2 \times 4}$ or $b^2 - 4ac = 4^2 - 4 \times 4 \times 1$ or D(iscriminant) = $4^2 - 4 \times 4 \times 1$	A1	oe eg $\left(x + \frac{1}{2}\right)^2 (= 0)$ allow $b^2 - 4ac = 16 - 16$ or D(iscriminant) = $16 - 16$
	$(x =) -\frac{1}{2}$ with no other solutions with M2A1 seen or states that as brackets are the same there is only one solution with M2A1 seen or $b^2 - 4ac = 4^2 - 4 \times 4 \times 1 = 0$ and states there is only one solution with M2A1 seen or D(iscriminant) = $4^2 - 4 \times 4 \times 1 = 0$ and states there is only one solution with M2A1 seen	A1	oe allow $b^2 - 4ac = 16 - 16 = 0$ and states there is only one solution with M2A1seen allow D(iscriminant) = $16 - 16 = 0$ and states there is only one solution with M2A1seen

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Question	Answer	Mark	Comments
26 cont	Alternative method 2		
	$y = 4(y - 2)^2 + 5(y - 2) + 3$	M1	oe
	$4y^2 - 16y + 16 + 5y - 10 + 3 - y$ (= 0) or $4y^2 - 12y + 9 (= 0)$	M1dep	oe expansion and collection of terms eg $4y^2 - 16y + 5y - y = 10 - 16 - 3$ or $4y^2 - 12y = -9$
	$(2y - 3)(2y - 3) (= 0)$ or $4\left(y - \frac{3}{2}\right)^2 (= 0)$ or $\frac{-(-12) \pm \sqrt{(-12)^2 - 4 \times 4 \times 9}}{2 \times 4}$ or $b^2 - 4ac = (-12)^2 - 4 \times 4 \times 9$ or D(iscriminant) = $(-12)^2 - 4 \times 4 \times 9$	A1	oe eg $\left(y - \frac{3}{2}\right)^2 (= 0)$ allow $b^2 - 4ac = 144 - 144$ or allow D(iscriminant) = $144 - 144$
	$(y =) \frac{3}{2}$ with no other solutions with M2A1 seen or states that as brackets are the same there is only one solution with M2A1 seen or $b^2 - 4ac = (-12)^2 - 4 \times 4 \times 9 = 0$ and states there is only one solution with M2A1 seen or D(iscriminant) = $(-12)^2 - 4 \times 4 \times 9 = 0$ and states there is only one solution with M2A1 seen	A1	oe allow $b^2 - 4ac = 144 - 144 = 0$ and states there is only one solution with M2A1seen allow D(iscriminant) = $144 - 144 = 0$ and states there is only one solution with M2A1seen

Additional guidance continues on the next page

Question	Answer	Mark	Comments
26 cont	Additional Guidance		
	Alt 1 $(x =) -\frac{1}{2}$ with no working or Alt 2 $(y =) \frac{3}{2}$ with no working		M0M0A0A0
	Alt 1 Ignore any y-coordinate whether correct $\left(= \frac{3}{2} \right)$ or incorrect		
	Alt 2 Ignore any x-coordinate whether correct $\left(= -\frac{1}{2} \right)$ or incorrect		
	T & I leading to $x = -\frac{1}{2}$		M0M0A0A0
	To award M1dep you must see a correct expression with terms collected or a correct equation with terms collected		
	$4x^2 + 5x + 3 = x + 2$ $4x^2 + 1 = -4x$ (all x terms not collected on one side)		M1 M0dep
	$4x^2 + 5x + 3 = x + 2$ $4x^2 + 4x + 3 = 2$ (all constant terms not collected on one side)		M1 M0dep
	If using the discriminant to award A marks, you must see either $b^2 - 4ac$ or D(iscriminant) $b^2 - 4ac = 4^2 - 4 \times 4 \times 1$ can be implied eg $b + \sqrt{b^2 - 4ac}$ and $4 + \sqrt{4^2 - 4 \times 4 \times 1}$ scores first A1 For final A1 must see $b^2 - 4ac = 4^2 - 4 \times 4 \times 1 = 0$ and statement that there is only one solution with M2A1 seen		

Question	Answer	Mark	Comments
27	Alternative method 1 Working with 2.75.....		
	$10x = 27.5...$ or $100x = 275.5...$	M1	oe multiplication by a power of 10 eg $1000x = 2755.5...$ any letter
	$10x - x = 27.5... - 2.75...$ or $9x = 24.8$ with $10x = 27.5...$ seen or $100x - 10x = 275.5... - 27.5...$ or $90x = 248$ with $100x = 275.5...$ and $10x = 27.5...$ seen or $100x - x = 275.5... - 2.75...$ or $99x = 272.8$ with $100x = 275.5...$ seen	M1dep	oe subtraction to eliminate recurring digits eg $1000x - 10x = 2755.5... - 27.5...$ or $990x = 2728$ with $1000x = 2755.5...$ and $10x = 27.5...$ seen numbers must all be correct
	$x = 2.75...$ stated and M2 scored and $9x = 24.8$ and $x = \frac{24.8}{9} = \frac{124}{45}$ or $x = 2.75...$ stated and M2 scored and $90x = 248$ and $x = \frac{248}{90} = \frac{124}{45}$ or $x = 2.75...$ stated and M2 scored and $99x = 272.8$ and $x = \frac{272.8}{99} = \frac{124}{45}$	A1	oe eg $x = 2.75...$ stated and M2 scored and $990x = 2728$ and $x = \frac{2728}{990} = \frac{124}{45}$

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Question	Answer	Mark	Comments
27 cont	Alternative method 2 Working with 0.75.....		
	$10x = 7.5...$ or $100x = 75.5...$	M1	oe multiplication by a power of 10 eg $1000x = 755.5...$ any letter
	$10x - x = 7.5... - 0.75...$ or $9x = 6.8$ with $10x = 7.5...$ seen or $100x - 10x = 75.5... - 7.5...$ or $90x = 68$ with $100x = 75.5...$ and $10x = 7.5...$ seen or $100x - x = 75.5... - 0.75...$ or $99x = 74.8$ with $100x = 75.5...$ seen	M1dep	oe subtraction to eliminate recurring digits eg $1000x - 10x = 755.5... - 7.5...$ or $990x = 748$ with $1000x = 755.5...$ and $10x = 7.5...$ seen numbers must all be correct
	$x = 0.75...$ stated and M2 scored and $9x = 6.8$ and $x = \frac{6.8}{9}$ and $2\frac{6.8}{9} = \frac{124}{45}$ or $x = 0.75...$ stated and M2 scored and $90x = 68$ and $x = \frac{68}{90}$ and $2\frac{68}{90} = \frac{124}{45}$ or $x = 0.75...$ stated and M2 scored and $99x = 74.8$ and $x = \frac{74.8}{99}$ and $2\frac{74.8}{99} = \frac{124}{45}$	A1	oe eg $x = 0.75...$ stated and M2 scored and $990x = 748$ and $x = \frac{748}{990}$ and $2\frac{748}{990} = \frac{124}{45}$

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Question	Answer	Mark	Comments
27 cont	Alternative method 3 Working with 0.05....		
	$10x = 0.5\dots$ or $100x = 5.5\dots$	M1	oe multiplication by a power of 10 eg $1000x = 55.55\dots$ any letter
	$10x - x = 0.5\dots - 0.05\dots$ or $9x = 0.5$ with $10x = 0.5\dots$ seen or $100x - 10x = 5.5\dots - 0.5\dots$ or $90x = 5$ with $100x = 5.5\dots$ and $10x = 0.5\dots$ seen or $100x - x = 5.5\dots - 0.05\dots$ or $99x = 5.5$ with $100x = 5.5\dots$ seen	M1dep	oe subtraction to eliminate recurring digits eg $1000x - 10x = 55.5\dots - 0.5\dots$ or $990x = 55$ with $1000x = 55.5\dots$ and $10x = 0.5\dots$ seen numbers must all be correct
	$x = 0.05\dots$ stated and M2 scored and $9x = 0.5$ and $x = \frac{0.5}{9}$ and $2.7 + \frac{0.5}{9} = \frac{124}{45}$ or $x = 0.05\dots$ stated and M2 scored and $90x = 5$ and $x = \frac{5}{90}$ and $2.7 + \frac{5}{90} = \frac{124}{45}$ or $x = 0.05\dots$ stated and M2 scored and $99x = 5.5$ and $x = \frac{5.5}{99}$ and $2.7 + \frac{5.5}{99} = \frac{124}{45}$	A1	oe eg $x = 0.05\dots$ stated and M2 scored and $990x = 55$ and $x = \frac{55}{990}$ and $2.7 + \frac{55}{990} = \frac{124}{45}$

Additional guidance continues on the next page

Question	Answer	Mark	Comments
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27 cont	Additional Guidance		
	$124 \div 45 = 2.75\ldots$		M0M0A0
	Alt 1 M1dep oe subtraction to eliminate recurring decimals includes $100x - 10x = 248$ with $100x = 275.5\ldots$ and $10x = 27.5\ldots$ seen or $90x = 275.5\ldots - 27.5\ldots$ with $100x = 275.5\ldots$ and $10x = 27.5\ldots$ seen (apply same principle in Alts 2 and 3)		
	Alt 2 equivalents for final part of A1 eg For $2\frac{68}{90} = \frac{124}{45}$ allow $2 + \frac{68}{90} = \frac{124}{45}$		
	Alt 3 equivalents for final part of A1 eg For $2.7 + \frac{5}{90} = \frac{124}{45}$ allow $2 + \frac{7}{10} + \frac{5}{90} = \frac{124}{45}$		

28(a)	$5 - 2x$	B1	may be implied
	$3(x - 1) + 7$ or $3x + 4$	M1	oe ignore incorrect expansion if $3(x - 1) + 7$ seen
	$9 + x$	A1	
	Additional Guidance		
	Working out $2f(x)$		B0
	Working out $g(x + 1)$		M0

Question	Answer	Mark	Comments
28(b)	Alternative method 1		
	$x - 7 = 3y$ or $y - 7 = 3x$	M1	allow $x - 7 = 3g$ or $g - 7 = 3x$
	$\frac{x-7}{3}$ or $\frac{y-7}{3}$	A1	oe allow $\frac{g-7}{3}$
	-1.4 or $-\frac{7}{5}$	A1	oe
	Alternative method 2		
	$3(2x) + 7$	M1	oe
	$x = 3(2x) + 7$ or $x = 6x + 7$	A1	oe equation
	-1.4 or $-\frac{7}{5}$	A1	oe
	Additional Guidance		
	Beware $-3x - 7 = 2x$ leading to -1.4		M0A0A0