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# GCSE Mathematics

8300/2 – Paper 2 Higher Tier  
Mark scheme

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June 2018

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Version/Stage: 1.0 Final

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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](http://aqa.org.uk)

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## Glossary for Mark Schemes

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

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

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

Examiners should consistently apply the following principles

**Diagrams**

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

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

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

**Questions which ask students to show working**

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

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

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

**Misread or miscopy**

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

**Further work**

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

**Choice**

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

**Work not replaced**

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

**Work replaced**

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

**Premature approximation**

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

**Continental notation**

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

Question	Answer	Mark	Comments
1	segment	B1	
	<b>Additional Guidance</b>		
2	$6 \times 10^7$	B1	
	<b>Additional Guidance</b>		
3	3 : 2	B1	
	<b>Additional Guidance</b>		
4	400%	B1	
	<b>Additional Guidance</b>		

Question	Answer	Mark	Comments	
<b>5</b>	All 5 correct	B4	B3 for 4 correct B2 for 3 correct B1 for 1 or 2 correct	
	<b>Additional Guidance</b>			
			<b>B4</b>	
	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	<p><b>Alternative method 1</b></p> <p>Any one of  <math>\div</math> or <math>. \dots</math>                      or <math>.(\dots)\%</math> or <math>\frac{1}{7}</math>                      or  <math>\div</math> or <math>. \dots</math>                      or <math>.(\dots)\%</math> or <math>\frac{8}{7}</math>                      or  <math>420\,000 \div 60\,000</math> or 7                      or  <math>420\,000 \div 480\,000</math> or 0.875                      or 87.5% or <math>\frac{7}{8}</math>                      or  <math>\div</math> or <math>. \dots</math> or  <math>.(\dots)\%</math> or <math>\frac{1}{9}</math>                      or  <math>540\,000 \div 60\,000</math> or 9</p>	M1	<p>oe                      eg 60 000 : 420 000 or 1 : 7                      or                      480 000 : 420 000 or 8 : 7</p>
	<p>Any one of  <math>60\,000 \div 480\,000</math> or 0.125                      or 12.5% or <math>\frac{1}{8}</math>                      or  <math>540\,000 \div 480\,000</math> or 1.125                      or 112.5% or <math>\frac{9}{8}</math>                      or  <math>480\,000 \div 60\,000</math> or 8                      or  <math>\div</math> or <math>. \dots</math>                      or 0.89 or <math>.(\dots)\%</math> or <math>\%</math> or <math>\frac{8}{9}</math></p>		M1

Mark scheme continues on the next page

Question	Answer	Mark	Comments
<p><b>6 cont</b></p>	<p> <math>\frac{1}{7}</math> and <math>\frac{1}{8}</math> and No                      or  <math>\frac{8}{7}</math> and <math>\frac{9}{8}</math> and No                      or                      . ... and . and No                      or                      .(...)% and . % and No                      or                      . ... and . and No                      or                      .(...)% and 12.5% and No                      or                      7 and 8 and No                      or  <math>\frac{7}{8}</math> and <math>\frac{8}{9}</math> and No                      or  <math>\frac{1}{9}</math> and <math>\frac{1}{8}</math> and No                      or                      9 and 8 and No                      or                      . ... and . and No                      or                      .(...)% and . % and No                      or                      . and . ... or . and No                      or                      . % and .(...)% or % and No                 </p>	<p>A1</p>	<p>oe eg 1 : 7 and 1 : 8 and No</p>

Mark scheme continues on the next page

Question	Answer	Mark	Comments
<p style="text-align: center;"><b>6 cont</b></p>	<p><b>Alternative method 2</b></p>		
	<p>No and any one of  <math>\frac{60\,000}{420\,000} \times 480\,000</math> and                      [67200, 68640]                      or  <math>\frac{60\,000}{480\,000} \times 540\,000</math> and 67 500                      or  <math>\frac{60\,000}{480\,000} \times 420\,000</math> and 52 500                      or  <math>\frac{60\,000}{540\,000} \times 480\,000</math> and                      [52 800, 53 334]                      or  <math>\frac{420\,000}{480\,000} \times 540\,000</math> and 472 500                      or  <math>\frac{480\,000}{420\,000} \times 480\,000</math> and                      [547 200, 548 640]                      or  <math>\frac{480\,000}{540\,000} \times 480\,000</math> and                      [422 400, 427 200]                      or  <math>\frac{540\,000}{480\,000} \times 420\,000</math> and 472 500</p>	<p>B3</p>	<p>oe                       B2 any one of the calculations                      B1 any one of the fractions oe                       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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<b>Additional Guidance</b>			
<b>6 cont</b>	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)	Two different probabilities from $\frac{15}{20}$ or 0.75 or 75% or $\frac{22}{30}$ or . ... or .(...)% or $\frac{17}{40}$ or 0.425 or 0.43 or 42.5% or 43% or $\frac{54}{90}$ or 0.6 or 60% or $\frac{37}{50}$ or 0.74 or 74% or $\frac{32}{60}$ or . ... or .(...)% or $\frac{39}{70}$ or . ... or 0.56 or . ...% or %	B2	oe B1 for one correct probability

Additional guidance continues on the next page



Question	Answer	Mark	Comments
<b>7(b)</b>	<b>Alternative method 1 (ft their part (a))</b>		
	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
	<b>Alternative method 2 (independent of part (a))</b>		
	$\frac{54}{90}$ and valid reason eg Total throws	B1	oe
	<b>Additional Guidance</b>		
	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
<b>7(b) cont</b>	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
<b>8</b>	<b>Alternative method 1</b>		
	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

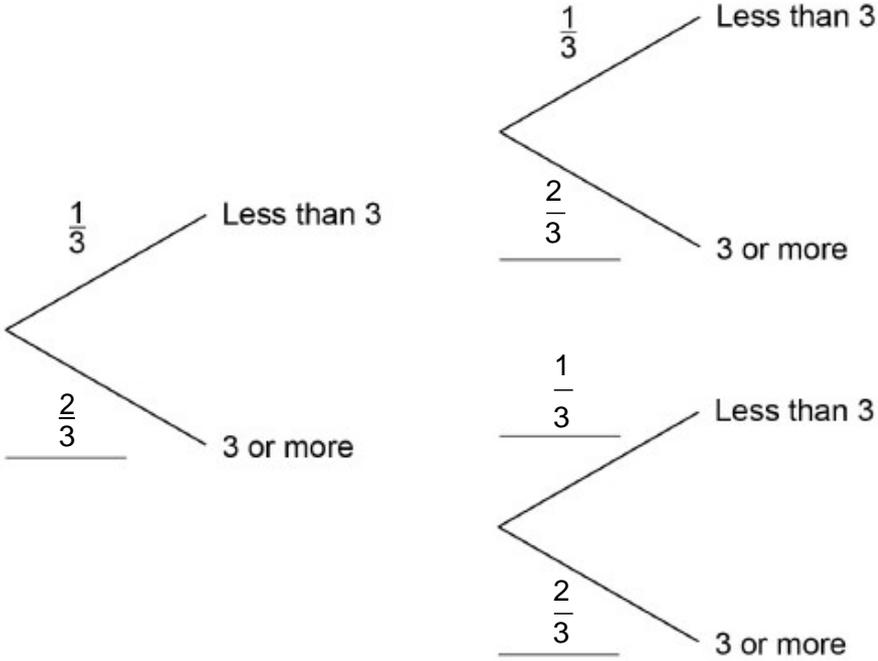
Question	Answer	Mark	Comments
<b>8 cont</b>	<b>Alternative method 2</b>		
	$18 + 4.5x$ and $4x$ seen or $\frac{18 + 4.5x}{15} = \frac{4x}{8}$	M1	any letter oe sets up correct equation
	$8(18 + 4.5x) = 60x$ or $144 + 36x = 60x$ or $24x = 144$	M1dep	eliminates denominators oe
	6	A1	
	<b>Additional Guidance</b>		
	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
	<b>Additional Guidance</b>		
	Do not accept . ... 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
	<b>Additional Guidance</b>		
	(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	<p><b>Alternative method 1</b></p> $\frac{4}{3}\pi \times 30^3 \text{ or } 36\,000\pi$ <p>or [112 757, 113 112]</p> <p>or</p> $\frac{1}{2} \times \frac{4}{3}\pi \times 30^3 \text{ or } 18\,000\pi$ <p>or [55 954, 56 839]</p>	M1	<p>oe</p> <p>allow . ... for <math>\frac{4}{3}</math></p> <p>allow . ... or . for <math>\frac{2}{3}</math></p>
	<p>their [112 757, 113 112] <math>\div</math> 4000 or <math>9\pi</math> or .(...)</p> <p>or</p> <p>their [55 954, 56 839] <math>\div</math> 4000 or <math>\frac{9\pi}{2}</math> or [13.9, 14.21]</p> <p>or</p> <p>their [112 757, 113 112] <math>\div</math> (4000 <math>\times</math> 60) or <math>\frac{3\pi}{20}</math> or [0.46, 0.4713]</p> <p>or</p> <p>their [55 954, 56 839] <math>\div</math> (4000 <math>\times</math> 60) or <math>\frac{3\pi}{40}</math> or . ... or 0.24</p>	M1dep	
	<p>[13.9, 14.21] and Yes</p> <p>or</p> <p>. ... or . and Yes</p>	A1	

Mark scheme and additional guidance continues on the next page

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

Question	Answer	Mark	Comments
	$\frac{1}{3}$ or $\frac{2}{6}$ or . ... or .(...)% on each top branch and $\frac{2}{3}$ or $\frac{4}{6}$ or . ... or . or .(...)% or % on each bottom branch	B1	accept any equivalent fraction, decimal or percentage
<b>Additional Guidance</b>			
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			
11(a)			B1

Question	Answer	Mark	Comments
11(b)	$\frac{1}{9}$ or . ... or (...)%	B1	
	<b>Additional Guidance</b>		
	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)	<b>Alternative method 1 Probabilities on branches in (a) all correct</b>		
	$\frac{1}{3} \times \frac{2}{3}$ or $\frac{2}{3} \times \frac{1}{3}$ or $\frac{2}{9}$	M1	oe accept . ... for $\frac{1}{3}$ accept . ... or . for $\frac{2}{3}$
	$\frac{4}{9}$ or . ... or (...)%	A1	
	<b>Alternative method 2 Probabilities on branches in (a) all correct</b>		
	$1 - \left(\frac{1}{3} \times \frac{1}{3}\right) - \left(\frac{2}{3} \times \frac{2}{3}\right)$	M1	oe accept . ... for $\frac{1}{3}$ accept . ... or . for $\frac{2}{3}$
	$\frac{4}{9}$ or . ... or (...)%	A1	

Mark scheme continues on the next page

Question	Answer	Mark	Comments
<b>11(c) cont</b>	<b>Alternative method 3 Probabilities on branches in (a) not all correct</b>		
	$\frac{1}{3}$ x their $\frac{2}{3}$ where their $\frac{2}{3}$ must be for 2nd dice 3 or more or their $\frac{2}{3}$ x 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 . ... for $\frac{1}{3}$ accept . ... or . for $\frac{2}{3}$ their fractions must be between 0 and 1
	$\frac{4}{9}$ or . ... or (...)%	A1ft	ft their fractions
	<b>Alternative method 4 Probabilities on branches in (a) not all correct</b>		
	$1 - \left(\frac{1}{3} \times \frac{1}{3}\right) - \left(\text{their } \frac{2}{3} \times \text{their } \frac{2}{3}\right)$ 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 . ... for $\frac{1}{3}$ accept . ... or . for $\frac{2}{3}$ their fractions must be between 0 and 1
	$\frac{4}{9}$ or . ... or (...)%	A1ft	ft their fractions

**Additional guidance continues on the next page**

Question	Answer	Mark	Comments
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<b>11(c) cont</b>	<b>Additional Guidance</b>		
	If probabilities on branches in (a) are all $\frac{1}{3}$	MOA0	
	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)		
	$\frac{1}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{1}{3}$	MOA0	
	$\frac{1}{3} \times \frac{2}{3}$ and $\frac{1}{3} \times \frac{1}{3}$ without selecting $\frac{1}{3} \times \frac{2}{3}$ is choice	MO	

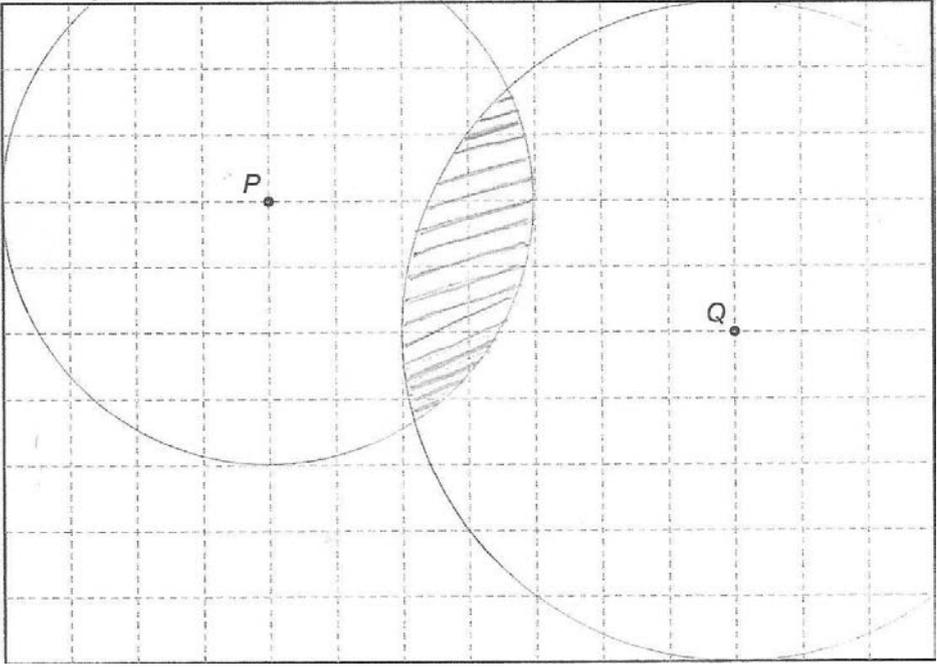
<b>12(a)</b>	$\frac{1}{2}$ or 0.5	B1	oe eg $\frac{4}{8}$ or $\frac{2}{4}$
	<b>Additional Guidance</b>		
	1 : 2 or 50%	B0	
	$\frac{1}{2}x$	B0	
	$y = 0.5x + 2$	B0	
	$\frac{0.5}{1}$	B0	
	Ignore units		

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

Question	Answer	Mark	Comments
13	<b>Alternative method 1</b>		
	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
<b>13 cont</b>	<b>Alternative method 2</b>		
	$4ax^2 + 4ax + 4bx + 4b$	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	
	<b>Additional Guidance</b>		
	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
<b>Additional Guidance</b>			
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	
	<b>Additional Guidance</b>		
16(a)	$2400 \times 3.8$ 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	
	<b>Additional Guidance</b>		
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	
	<b>Additional Guidance</b>		
	$\pi 0.5^2 h$	M1	

Question	Answer	Mark	Comments
17(a)	[2.9, 3]	B1	
	<b>Additional Guidance</b>		
17(b)	[1.4, 1.6]	B1	
	<b>Additional Guidance</b>		
17(c)	$\frac{[4.55, 4.65] - 0}{3.5 - [1.5, 1.6]}$ or $\frac{[4.55, 4.65]}{[1.9, 2]}$	M1	oe
	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]		
	[2.275, 2.45]	A1	
	<b>Additional Guidance</b>		
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
	<b>Additional Guidance</b>		
	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)		
	$\sqrt[5]{300} = . ( \dots )$ or . $\sqrt[6]{300} = . ( \dots )$ or 2.59 or 2.6		

Question	Answer	Mark	Comments
<b>19</b>	<b>Alternative method 1 Using one half of the isosceles triangle</b>		
	(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
	$\cos(\text{their } \quad)$ <del>or</del> $\frac{6}{\sin(\text{their } 55)}$ or $6^2 + (6 \tan(\text{their } 35))^2$ $\sqrt{\quad \cdot (\dots)}$	M1dep	oe
	[50.6, 50.65]	A1ft	ft B0M2 with evaluation of + x their . ( ...)

**Mark scheme and additional guidance continues on the next page**

Question	Answer	Mark	Comments
<b>19 cont</b>	<b>Alternative method 2 Using the isosceles triangle</b>		
	(base angle =) 35 or (top angle =) 110	B1	may be on diagram
	$\frac{x}{\sin(35)} = \frac{12}{\sin(110)}$ (their 35) or $12^2 = x^2 + x^2 - 2 \times x \times x \times \cos(110)$ (their 110) or $x^2 = x^2 + 12^2 - 2 \times x \times 12 \times \cos(35)$ (their 35)	M1	oe any letter their 35 must be acute their 110 cannot be 125
	$\frac{12}{\sin(110)} \times \sin(35)$ or $\sqrt{\frac{12^2}{2 - 2 \cos(110)}}$ or $\frac{12^2}{2 \times 12 \times \cos(35)}$ or . ( ... )	M1dep	oe
	[50.6, 50.65]	A1ft	ft B0M2 with evaluation of + x their . ( ... )
	<b>Additional Guidance</b>		
	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 $\pi$ as [3.14, 3.142]
	[12 320, 12 340.21]	A1	may be implied
	12 300 or $1.23 \times 10^4$ with no value outside [12 320, 12 340.21] seen	A1	
	<b>Additional Guidance</b>		
	$0.25\pi^2(30 - 20)^2(30 + 20)$ 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
<b>21(a)</b>	<b>Alternative method 1</b>		
	$80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$ or $6400 + 3600 - 9600 \cos 75$ or $\dots$	M1	oe
	$\sqrt{\text{their } 7515 \dots}$ 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
	<b>Alternative method 2</b>		
	$80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$ or $6400 + 3600 - 9600 \cos 75$ or $\dots$	M1	oe
	$(80^2 =)$ and $\dots$ and Liz	A2	
	<b>Additional Guidance</b>		
	$80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$ 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	
	$\sqrt{103.5}$		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
<b>21(b)</b>	<b>Alternative method 1 (answer Liz in (a))</b>		
	No change	B1	oe eg Liz will still arrive first or Liz will be there even earlier (than Tia)
	<b>Alternative method 2 (answer Tia in (a))</b>		
	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
	<b>Alternative method 3 (answer they arrive at same time in (a))</b>		
	Liz will arrive first	B1ft	oe eg Liz wins
	<b>Alternative method 4 (neither Liz or Tia in (a))</b>		
	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
	<b>Additional Guidance</b>		
	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	
<b>22</b>	$x^2 + y^2 = 25$	B1	
	<b>Additional Guidance</b>		

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 $\left(\frac{7}{4}\right)^2$ or $\frac{49}{16}$ or $\left(\frac{4}{7}\right)^2$ or $\frac{16}{49}$
	539	A1	
<b>Additional Guidance</b>			
	$4^3$ 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 $11 \times 49$		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
<b>24</b>	<b>Alternative method 1</b>		
	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
	$34 \times 1000$ or 34 000	M1	converts to $\text{cm}^3$
their volume < 34 000 and their volume > 34 000 and 34 000 and ticks Cannot tell	A1	both volumes in $\text{cm}^3$ 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
<b>24 cont</b>	<b>Alternative method 2</b>		
	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
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Additional Guidance			
<b>24 cont</b>	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]		
	$. \times . \times . = .(\dots) \text{ or } \text{ or}$ $49.6 \times 34.6 \times 19.6 = [33\ 636, 33\ 637] \text{ or } 33\ 000 \text{ or } 33\ 600 \text{ or } 33\ 630$ or 33 640 $. \times . \times . = .(\dots) \text{ or } \text{ or } \text{ or}$ $. \times . \times . = .(\dots) \text{ or } \text{ or}$ $49.9 \times 34. \times . = .(\dots) \text{ or } \text{ or } \text{ or } \text{ or}$ $50 \times 35 \times 20 = 35\ 000$ $. \times . \times . = .(\dots) \text{ or } \text{ or } \text{ or } \text{ or}$ $. \times . \times . = .(\dots) \text{ or } \text{ or } \text{ or } \text{ or}$ or 35 690 $. \times . \times . = .(\dots) \text{ or } \text{ or}$ $50.4 \times 35.4 \times 20.4 = [36\ 396, 36\ 397] \text{ or } 36\ 000 \text{ or } 36\ 300 \text{ or } 36\ 400$ or 36 390 $. \times . \times . = .(\dots) \text{ or } \text{ or } \text{ or } \text{ or}$ or 36 750		
	Three valid dimensions do not have to follow a pattern eg $. \times \times . (= .(\dots) \text{ or } \text{ or } \text{ or } )$		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 . ... or . or . or ...% or . % or %	A1	
	<b>Additional Guidance</b>		
	Accept $\frac{7}{12} = 35$		M1
	Ignore any incorrect cancelling or change of form (fraction, decimal or percentage)		

Question	Answer	Mark	Comments
26	<b>Alternative method 1</b>		
	$4x^2 + 5x + 3 = x + 2$	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 M2A1 seen  allow D(iscriminant) = $16 - 16 = 0$ and states there is only one solution with M2A1 seen

Mark scheme continues on the next page



Question	Answer	Mark	Comments
<b>26 cont</b>	<b>Additional Guidance</b>		
	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	<b>Alternative method 1 Working with 2.75.....</b>		
	$10x = 27.5\dots$ or $100x = 275. \dots$	M1	oe multiplication by a power of 10 eg $1000x = \dots$ any letter
	$10x - x = 27.5\dots - \dots$ or $9x = 24.8$ with $10x = 27.5\dots$ seen or $100x - 10x = 275. \dots - 27.5\dots$ or $90x = 248$ with $100x = 275.5\dots$ and $10x = 27.5\dots$ seen or $100x - x = 275. \dots - 2.75\dots$ or $99x = 272.8$ with $100x = 275. \dots$ seen	M1dep	oe subtraction to eliminate recurring digits eg $1000x - 10x = \dots - 27.5\dots$ or $990x = 2728$ with $1000x = \dots$ and $10x = 27.5\dots$ seen numbers must all be correct
$x = 2. \dots$ stated and M2 scored and $9x = 24.8$ and $x = \frac{24.8}{9} = \frac{124}{45}$ or $x = \dots$ stated and M2 scored and $90x = 248$ and $x = \frac{248}{90} = \frac{124}{45}$ or $x = \dots$ stated and M2 scored and $99x = 272.8$ and $x = \frac{272.8}{99} = \frac{124}{45}$	A1	oe eg $x = \dots$ stated and M2 scored and $990x = 2728$ and $x = \frac{2728}{990} = \frac{124}{45}$	

Mark scheme continues on the next page

Question	Answer	Mark	Comments
<b>27 cont</b>	<b>Alternative method 2 Working with 0.75.....</b>		
	$10x = \dots$ or $100x = \dots$	M1	oe multiplication by a power of 10 eg $1000x = \dots$ any letter
	$10x - x = 7.5\dots - \dots$ or $9x = 6.8$ with $10x = \dots$ seen or $100x - 10x = \dots - \dots$ or $90x = 68$ with $100x = \dots$ and $10x = \dots$ seen or $100x - x = \dots - \dots$ or $99x = 74.8$ with $100x = \dots$ seen	M1dep	oe subtraction to eliminate recurring digits eg $1000x - 10x = \dots - \dots$ or $990x = 748$ with $1000x = \dots$ and $10x = \dots$ seen numbers must all be correct
$x = 0. \dots$ stated and M2 scored and $9x = 6.8$ and $x = \frac{6.8}{9}$ and $2 \frac{6.8}{9} = \frac{124}{45}$ or $x = 0. \dots$ stated and M2 scored and $90x = 68$ and $x = \frac{68}{90}$ and $2 \frac{68}{90} = \frac{124}{45}$ or $x = 0. \dots$ 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 $x = 0. \dots$ stated and M2 scored and $990x = 748$ and $x = \frac{748}{990}$ and $2 \frac{748}{990} = \frac{124}{45}$	

Mark scheme continues on the next page

Question	Answer	Mark	Comments
<b>27 cont</b>	<b>Alternative method 3 Working with 0.05.....</b>		
	$10x = 0. \dots$ or $100x = \dots$	M1	oe multiplication by a power of 10 eg $1000x = 55.5 \dots$ any letter
	$10x - x = 0. \dots - 0.0 \dots$ or $9x = 0.5$ with $10x = \dots$ seen or $100x - 10x = \dots - 0. \dots$ or $90x = 5$ with $100x = \dots$ and $10x = \dots$ seen or $100x - x = \dots - 0.0 \dots$ or $99x = 5.5$ with $100x = \dots$ seen	M1dep	oe subtraction to eliminate recurring digits eg $1000x - 10x = \dots - 0. \dots$ or $990x = 55$ with $1000x = \dots$ and $10x = \dots$ seen numbers must all be correct
$x = 0.0 \dots$ 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 $x = 0.0 \dots$ stated and M2 scored and $90x = 5$ and $x = \frac{5}{90}$ and $2.7 + \frac{5}{90} = \frac{124}{45}$ or $x = 0.0 \dots$ 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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Additional Guidance			
	$\div = . \dots$		MOMOA0
	Alt 1 M1dep oe subtraction to eliminate recurring decimals includes $100x - 10x = 248$ with $100x = \dots$ and $x = \dots$ seen or $90x = \dots - \dots$ with $x = \dots$ and $x = \dots$ seen (apply same principle in Alts 2 and 3)		
<b>27 cont</b>	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 $2 + \frac{7}{10} + \frac{5}{90} = \frac{124}{45}$		

<b>28(a)</b>	$5 - 2x$	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	
	<b>Additional Guidance</b>		
	Working out $2f(x)$		B0
	Working out $g(x + 1)$		M0

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