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# GCSE Mathematics

Paper 1 Higher Tier

Mark scheme

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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)

## 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	10	B1	
2	$8 \times 10^8$	B1	
3	$16a^{10}$	B1	
4	$\div 2$	B1	
5(a)	$(x - 10)(x + 10)$	B1	either order ignore fw
	<b>Additional Guidance</b>		
	$(x + 10)(x + -10)$		B1
	Condone missing bracket at end only $(x - 10)(x + 10)$ $(x - 10(x + 10))$		B1 B0
	$(x - 10)(x + 10)$ followed by attempt to solve, eg answer $x = 10, x = -10$		B1
	answer only $x = 10, x = -10$		B0
5(b)	$7x - 2x > 1 - 6$ or $5x > -5$ or $6 - 1 > 2x - 7x$ or $5 > -5x$ or $1 > -x$	M1	oe collecting terms
	$x > -1$ or $-1 < x$	A1	SC1 incorrect sign eg $x \geq -1$ or $x = -1$ or answer of $-1$
	<b>Additional Guidance</b>		
	Answer $x > \frac{-5}{5}$		M1A0
	Answer only $\frac{-5}{5}$		SC0
	$x > -1$ with $-1$ or $0, 1, 2 \dots$ as the answer		M1A0

Question	Answer	Mark	Comments	
6	$((\sqrt{3})^2 =) 3$ and $((\sqrt{2})^2 =) 2$ or $(\sqrt{6})^2$ or $\sqrt{6^2}$ or $\sqrt{36}$ or $\sqrt{9} \times \sqrt{4}$ or $\sqrt{9 \times 4}$	M1		
	6	A1		
	<b>Additional Guidance</b>			
	3 × 2 = 6 with answer eg $\sqrt{6}$ or $6^4$			M0A0
	Condone $\sqrt{3} = 1.7$ , $1.7^2 = 3$ and $\sqrt{2} = 1.4$ , $1.4^2 = 2$ , otherwise $\sqrt{3}$ or $\sqrt{2}$ or $3^2$ or $2^2$ incorrectly evaluated does not score, even if answer is 6 eg $\sqrt{3} = 1.5$ , $1.5^2 = 3$ $\sqrt{2} = 1$ , $1^2 = 2$ , answer 6 $3^2 = 6$ , $\sqrt{6} = 3$ $(\sqrt{6})^4$ $\sqrt{2} = 1$			M0A0 M0A0 M0 M0A0 M0
7	$\pi \times 6 \times 6$ or $36\pi$ or [113, 113.112] or $9 \times [3.14, 3.142]$ or [28.26, 28.3]	M1	oe accept [3.14, 3.142] for $\pi$	
	$9\pi$ or $9 \times \pi$ or $\pi 9$ or $\pi \times 9$	A1		
	<b>Additional Guidance</b>			
	36 $\pi$ followed by an incorrect method eg $36\pi \div 2 = 18\pi$ with answer 18 $\pi$			M1A0
	Answer of 9 $\pi$ from $\pi \times 3^2$			M0A0
	9 $\pi$ and [28.26, 28.3] given on answer line			M1A0
$\pi 7^2$ stated but followed by 36 or 9			M0A0	

Question	Answer	Mark	Comments
8	<b>Alternative method 1</b>		
	Three whole numbers that each are less than 80 and have units digit 4 or States that each number must have units digit 4	M1	
	82	A1	
	<b>Alternative method 2</b>		
	Correctly evaluated trial for three whole numbers, none of which are a multiple of 10, and that, when rounded, total 70	M1	eg $33 + 33 + 13 = 79$
	82	A1	
	<b>Additional Guidance</b>		
	$39 + 33 + 13 = 85$ ( $40 + 30 + 10 = 80$ )		M0
	Beware 82 from incorrect values, eg $39 + 24 + 19 = 82$		MOA0
	Ignore incorrectly evaluated trials that do not solely lead to the answer		
9	$n - 1$	B1	

Question	Answer	Mark	Comments	
10(a)	$\frac{1}{2}(b+2b)h$ or $3 \times \frac{1}{2}bh$	M1	oe	
	$1.5bh$ or $\frac{3}{2}bh$ or $\frac{3bh}{2}$ or $1\frac{1}{2}bh$	A1	accept $hb$ for $bh$	
	<b>Additional Guidance</b>			
	Correct expression with $\times$ , $\div$ or brackets		M1A0	
	Condone units within expressions for M1 only			
	Condone the expression given within a formula eg $A = 1.5hb$		M1A1	
	Condone correct expression stated and then equated to a value or with values substituted		M1A1	
10(b)	$3b + 2s$ or $3b = 2s$ or $4s$	M1	oe	
	$6b$	A1	oe eg $b + b + b + b + b + b$	
	<b>Additional Guidance</b>			
	Condone the expression given within a formula eg $P = 6b$		M1A1	



Question	Answer	Mark	Comments
11	<b>Alternative method 1</b>		
	$x + 2x + 2x + 10$ or $5x + 10$ or $x + 2x + 2x + 10 + 90$ or $5x + 100$	M1	oe
	$x + 2x + 2x + 10 = 360 - 90$ or $5x + 10 = 270$ or $x + 2x + 2x + 10 + 90 = 360$ or $5x + 100 = 360$ or $5x = 260$	M1dep	oe
	$(x =) 52$ or $2x = 104$ or $2x + 10 = 114$	A1	May be on diagram
	$\frac{114}{360}$ or $\frac{57}{180}$ or $\frac{38}{120}$ or $\frac{19}{60}$ or 0.31(6..) or 0.317 or 0.32 or 31(.6...) % or 31.7% or 32%	B1ft	ft $\frac{2 \times \text{their } 52 + 10}{360}$ or $\frac{\text{their angle for C}}{360}$
	<b>Alternative method 2</b>		
	$\frac{90}{360} + \frac{x}{360} + \frac{2x}{360} + P(C) = 1$ or $\frac{90}{360} + \frac{x}{360} + \frac{2x}{360} + \frac{2x + 10}{360}$ or $\frac{2x + 10}{5x + 100}$	M1	oe
	$\frac{90}{360} + \frac{x}{360} + \frac{2x}{360} + \frac{2x + 10}{360} = 1$	M1dep	oe
	$(x =) 52$ or $2x = 104$ or $2x + 10 = 114$	A1	May be on diagram
	$\frac{114}{360}$ or $\frac{57}{180}$ or $\frac{38}{120}$ or $\frac{19}{60}$ or 0.31(6..) or 0.317 or 0.32 or 31(.6...) % or 31.7% or 32%	B1ft	ft $\frac{2 \times \text{their } 52 + 10}{360}$ or $\frac{\text{their angle for C}}{360}$

<b>Additional Guidance</b>	
<b>11 cont</b>	Ignore incorrect simplification or conversion after $\frac{114}{360}$ oe <span style="float: right;">M1M1A1B1</span>
	$\frac{360 - 10 - 90}{5}$ oe <span style="float: right;">M1M1</span>
	$x + 2x + 2x + 10$ followed by $6x + 10 = 270$ <span style="float: right;">M1M0</span>
	Do not accept decimal within fraction for final answer if correct fraction not seen
	The follow through is not available if A1 awarded

<b>12</b>	Any two of 0.5, 40 and 100	M1	1600 implies 40 10 implies 100
	$(40^2 =) 1600$ or $(0.5 \times 40^2 =) 800$ or $(\sqrt{100} =) 10$	M1	
	80 with correct working	A1	
	<b>Additional Guidance</b>		
	$\frac{0.5 \times 1600}{\sqrt{100}}$ or $\frac{0.5 \times 40^2}{10}$ or $\frac{1 \times 1600}{10}$ or $\frac{800}{\sqrt{100}}$ or $\frac{800}{10}$		M1M1
	80 with no or incorrect working, eg attempt at actual calculation and then rounding to 80		M0M0A0
	Condone 0.50(0) for 0.5, 40.0(0) for 40 and 100.0(0) for 100 etc		
	Rounding 0.526 to 1, but otherwise correct, with answer 160		M1M1A0

Question	Answer	Mark	Comments	
13	<b>Alternative method 1</b>			
	$88 \div (7 + 4)$ or $88 \div 11$ or 8	M1	oe $11 \times 8 = 88$	
	their $8 \times 7$ and their $8 \times 4$ or their $8 \times 7$ and $88 -$ their value or their $8 \times 4$ and $88 -$ their value or 56 and 32 or their $8 \times (7 - 4)$ or their $8 \times 3$	M1dep	oe eg $8 \times 7 = 63$ and $88 - 63$ eg $8 \times 4 = 30$ and $88 - 30$	
	24	A1		
	<b>Alternative method 2</b>			
	One correctly evaluated trial for two numbers, other than 7 and 4, in the ratio 7 : 4	M1	eg $70 + 40 = 110$	
	56 and 32	M1dep	eg $56 + 32 = 88$	
	24	A1		
	<b>Alternative method 3</b> using $x : y = 7 : 4$ (correct)			
	$4x = 7y$ and $4x + 4y = 352$	$4x = 7y$ and $7x + 7y = 616$	M1	oe forming equation from ratio and equating coefficients
	$11y = 352$ or $y = 32$	$11x = 616$ or $x = 56$	M1dep	oe equation in one variable
	24	A1		
	<b>Alternative method 4</b> using $x : y = 4 : 7$ (incorrect)			
	$7x = 4y$ and $4x + 4y = 352$	$7x = 4y$ and $7x + 7y = 616$	M1	oe forming equation from ratio and equating coefficients
	$11x = 352$ or $x = 32$	$11y = 616$ or $y = 56$	M1dep	oe equation in one variable
	their answer	A0		

<b>13 cont</b>	<b>Alternative method 5</b> using $x : y = 7 : 4$ (correct)		
	$x = \frac{7}{4}y$ or $y = \frac{4}{7}x$ or $x = 88 - y$ or $y = 88 - x$	M1	oe making one variable the subject
	$\frac{7y}{4} + y = 88$ or $\frac{11}{4}y = 88$ or $x + \frac{4}{7}x = 88$ or $\frac{11}{7}x = 88$	M1dep	oe equation in one variable
	24	A1	
	<b>Alternative method 6</b> using $x : y = 4 : 7$ (incorrect)		
	$y = \frac{7}{4}x$ or $x = \frac{4}{7}y$ or $x = 88 - y$ or $y = 88 - x$	M1	oe making one variable the subject
	$\frac{7x}{4} + x = 88$ or $\frac{11}{4}x = 88$ or $y + \frac{4}{7}y = 88$ or $\frac{11}{7}y = 88$	M1dep	oe equation in one variable
	their answer	A0	
	<b>Additional Guidance</b>		
	–24 with no incorrect working implies 56 and 32		M1M1A0
$x = 32$ and $y = 56$		M1M1A0	

Question	Answer	Mark	Comments
14	<b>Alternative method 1</b>		
	$60 \div 2$ or 30	M1	exterior angle may be on diagram
	$360 \div$ their 30	M1dep	
	12	A1	
	<b>Alternative method 2</b>		
	$\frac{360 - 60}{2}$ or $\frac{300}{2}$ or 150	M1	interior angle may be on diagram
	$360 \div (180 -$ their 150) or $360 \div 30$	M1dep	
	12	A1	
	<b>Alternative method 3</b>		
	$\frac{360 - 60}{2}$ or $\frac{300}{2}$ or 150	M1	interior angle may be on diagram
	$180 \times (n - 2) =$ their $150 \times n$ or $180n -$ their $150n = 360$ or $30n = 360$	M1dep	oe equation
	12	A1	

Question	Answer	Mark	Comments
15(a)	$7 \times 5 \times 3$	M1	oe $35 \times 3$
	105	A1	
	<b>Additional Guidance</b>		
	105 given with further work		M1A0
15(b)	<b>Alternative method 1</b>		
	$\frac{2}{7} \times \frac{3}{5}$ or $\frac{2 \times 3}{7 \times 5}$	M1	oe
	$\frac{6}{35}$	A1	oe
	<b>Alternative method 2</b>		
	$\frac{2 \times 3 \times 3}{\text{their } 105}$	M1	their 105 from (a)
	$\frac{18}{\text{their } 105}$ or $\frac{6}{35}$	A1ft	oe ft their 105 from (a) if $0 < \text{probability} < 1$
	<b>Additional Guidance</b>		
	Ignore incorrect simplification or conversion after a correct fraction		M1A1
	$\frac{2}{7} \times \frac{3}{5}$ or $\frac{6}{35}$ with further work other than simplification or conversion		M1A0
$\frac{2}{7} + \frac{3}{5}$		M0A0	
16	15 litres	B1	

Question	Answer	Mark	Comments
17	Ticks No and gives correct reason or ticks No and gives numerical counter-example for any solid	B1	eg1 (volume of) A is 8 times bigger eg2 (volume) sf = $2^3$ eg3 if A and B are cubes and $l = 3$ , volume of A = 27 volume of B = 216 216 is not $27 \times 2$
	<b>Additional Guidance</b>		
	Condone $8l^3$		B1
	No, as the height/width is (also) doubled/different		B1
	No, as the length/volume is cubed		B0
	No, volume is $l^3$		B0
	No, as the height could be different		B0
No, it would be 3 times as big		B0	
Doubling the length doesn't double the volume		B0	
18	$-\frac{3}{2}$ and $\frac{2}{5}$	B1	
19	$a + 65 + 115 + c = 360$ or $b + c = 180$	M1	oe oe
	$a + c = 180$ and $b + c = 180$ and $a = b$	A1	oe eg $c = 180 - a$ $b = 180 - (180 - a)$ $= a$
	angles at a point and (co)interior angles	A1	
	<b>Additional Guidance</b>		
	Accept angles round a point for angles at a point		
Accept allied angles for interior angles			

Question	Answer	Mark	Comments
20	Median ticked and a valid reason for not using mode (eg there is no mode) and a valid reason for not using mean (eg 82 will affect the mean disproportionately)	B2	B1 median ticked or valid reason to reject mean or valid reason to reject mode with any box or no box ticked
	<b>Additional Guidance</b>		
	Accept any indication in place of a tick		
	Ignore non-contradictory statements alongside a correct reason		
	Median ticked with reasons “There is no mode” and “82 would skew the mean”		B2
	No box or mode ticked with reason “Not mean, because of the 82”		B1
	No box or mean ticked with reason “Not mode, all the numbers are different”		B1
	No box or mode ticked with statement that 82 is very large		B0
	Condone “one number” oe for “82” in reason for mean if intention is clear, eg “One of the numbers is far bigger than the others”		
	Do not accept reasons for the mean indicating that 12.7 is too high unless 82 is also mentioned		
	Do not accept reasons given with the wrong measure eg “It cannot be the mean as they’re all different”		
	Do not accept a reason which simply defines mean and mode		
	Giving reasons for mode and mean does not imply a selection of median – the box must be ticked to achieve both marks		
	Median ticked with two valid reasons which are not attributed to median and mode eg median ticked and “There is not a repeated number” and “82 is far too high to calculate the average”		B2
Otherwise, reasons must be attributed			



Question	Answer	Mark	Comments
21	Set of 3 points that give area 28 and $A$ on positive $y$ -axis and $B$ on negative $y$ -axis and $C$ on positive $x$ -axis	B2	eg1 $A(0, 10) B(0, -4) C(4, 0)$ eg2 $A(0, 18) B(0, -10) C(2, 0)$  B1 diagram labelled with numbers that give area 28 eg $A$ labelled 20, $B$ labelled $-8$ , $C$ labelled 2  or calculation of form $\frac{b \times h}{2}$ seen that equals 28 or $b \times h$ that equals $2 \times 28$ eg $\frac{8 \times 7}{2} (= 28)$ or $8 \times 7 (= 56)$
22(a)	(6) 22 50 60	B1	cumulative frequency values may be implied by points plotted ( $\pm 0.5$ square)
	Points plotted with upper class boundaries and cf values ( $\pm 0.5$ square)	B1ft	ft their cumulative frequencies must be increasing
	Smooth curve or polygon ( $\pm 0.5$ square)	B1ft	ft their cumulative frequencies must be increasing and not a single straight line
	<b>Additional Guidance</b>		
	Graphs may start from their first plotted point or from $(40, 0)$ If the points are plotted at mid-points, with a point at $(45, 6)$ , the graph may start at $(35, 0)$ ( $\pm 0.5$ square) If the points are plotted at the lower bounds, with a point at $(40, 6)$ , the graph may start at $(0, 0)$		
	Graph starting at $(0, 0)$ , but otherwise correct		B1B1B0
	Graph plotted at mid-points or lower class boundaries, but otherwise correct		B1B0B1
	Graph ascends or descends after $x = 80$		B0 for 3 <sup>rd</sup> mark
	Bars drawn as well as correct graph		B1B1B0
	Bars drawn without correct graph		max B1

Question	Answer	Mark	Comments
22(b)	One correct mpg reading for their graph from cf of 15(.25) or 45(.75) or horizontal lines from 15(.25) and 45(.75) only to their graph or 15(.25) and 45(.75) indicated as the cf values for the quartiles	M1	$\pm 0.5$ square ft their increasing graph  may be on table
	Correct value for their increasing graph	A1ft	
23	(-3, 5)	B1	
24	<b>Alternative method 1</b>		
	$180 \div (5 + 7)$ or $180 \div 12$ or 15	M1	oe
	5 x their 15 or $180 - 7 \times$ their 15 or 75	M1dep	oe
	$180 -$ their 75 - 20 or $180 - 95$	M1dep	oe
	85	A1	
	<b>Alternative method 2</b>		
	$x + \frac{7x}{5} = 180$ or $\frac{5y}{7} + y = 180$ or $y = 105$	M1	oe correct elimination of a variable from equations $x + y = 180$ and $7x = 5y$
	$(x =) 180 \times \frac{5}{12}$ or $(x =) 75$	M1dep	oe
	$180 -$ their 75 - 20 or $180 - 95$	M1dep	oe
85	A1		

Question	Answer	Mark	Comments
25	<b>Alternative method 1</b>		
	15 × 8 or 120 or 3 × 6 or 18	M1	oe total number of hours needed oe total number of hours worked by the 3 machines
	15 × 8 – 3 × 6 or 102	M1dep	oe total number of hours worked by the other 12 machines
	8.5	A1	
	<b>Alternative method 2</b>		
	3 × (8 – 6) or 3 × 2 or 6	M1	oe total number of hours not worked by the three machines
	their 6 ÷ 12 or 0.5	M1dep	oe that number divided by the other 12 machines
	8.5	A1	
	<b>Alternative method 3</b>		
	15 × 8 or 120 or 15 × 6 or 90	M1	oe total number of hours needed oe total number of hours worked in the first 6 hours
	$\frac{15 \times 8 - 15 \times 6}{12}$ or 2.5	M1dep	oe number of remaining hours divided by the other 12 machines
	8.5	A1	
	<b>Additional Guidance</b>		
	Note that 15 ÷ 6 is not a correct method to get 2.5 (unless simplified from 30 ÷ 12), so does not score		

Question	Answer	Mark	Comments	
26(a)	$0.\dot{7} \div 10 = 0.0\dot{7}$ and $\frac{7}{9} \div 10 = \frac{7}{90}$ or $0.0\dot{7} \times 10 = 0.\dot{7}$ and $\frac{7}{90} \times 10 = \frac{7}{9}$ or $0.\dot{7} \div 10 = 0.0\dot{7}$ and $\frac{7}{90} \times 10 = \frac{7}{9}$ or because the decimal is divided by 10 the 9 has to be multiplied by 10	B1	oe	
	<b>Additional Guidance</b>			
	Algebraic methods		B0	
	Division of 7 by 90		B0	

Question	Answer	Mark	Comments
26(b)	<b>Alternative method 1</b>		
	$0.2 + 0.0\dot{7}$ or $\frac{2}{10} + \frac{7}{90}$	M1	
	$\frac{18}{90} + \frac{7}{90}$ or $\frac{25}{90}$	M1dep	
	$\frac{5}{18}$	A1	
	<b>Alternative method 2</b>		
	$10x = 2.777\dots$ or $100x = 27.777\dots$	M1	Any letter
	$10x - x = 2.777\dots - 0.277\dots$ or $9x = 2.5$ or $\frac{2.5}{9}$ or $100x - x = 27.777\dots - 0.277\dots$ or $99x = 27.5$ or $\frac{27.5}{99}$ or $100x - 10x = 27.777\dots - 2.777\dots$ or $90x = 25$ or $\frac{25}{90}$	M1dep	oe
	$\frac{5}{18}$	A1	

Question	Answer	Mark	Comments
27	<b>Alternative method 1</b>		
	(B, B) $\frac{8}{11}$ and $\frac{7}{10}$ or (R, R) $\frac{3}{11}$ and $\frac{2}{10}$	M1	oe may be seen on tree diagram
	(B, B) $\frac{8}{11} \times \frac{7}{10}$ or $\frac{56}{110}$ or (R, R) $\frac{3}{11} \times \frac{2}{10}$ or $\frac{6}{110}$	M1dep	oe may be seen on tree diagram
	$\frac{8}{11} \times \frac{7}{10} + \frac{3}{11} \times \frac{2}{10}$	M1dep	$\frac{56}{110} + \frac{6}{110}$
	$\frac{62}{110}$ or $\frac{31}{55}$	A1	oe fraction accept 0.56(...) or 56.(...)%
	<b>Alternative method 2</b>		
	(B, R) $\frac{8}{11}$ and $\frac{3}{10}$ or (R, B) $\frac{3}{11}$ and $\frac{8}{10}$	M1	oe may be seen on tree diagram
	(B, R) $\frac{8}{11} \times \frac{3}{10}$ or (R, B) $\frac{3}{11} \times \frac{8}{10}$ or $\frac{24}{110}$	M1dep	oe may be seen on tree diagram
	$1 - \frac{8}{11} \times \frac{3}{10} - \frac{3}{11} \times \frac{8}{10}$	M1dep	$1 - \frac{24}{110} - \frac{24}{110}$
	$\frac{62}{110}$ or $\frac{31}{55}$	A1	oe fraction accept 0.56(...) or 56.(...)%
	<b>Additional Guidance</b>		
	Ignore incorrect simplification or conversion after a correct fraction		M3A1
$\frac{6820}{12100}$		M3A1	

Question	Answer	Mark	Comments
28(a)	$(0^2 +) 6^2 = 36$ or $(OA =) \text{ radius} = 6$ or $\sqrt{36} = 6$	B1	oe
	<b>Additional Guidance</b>		
	$0 + 36 = 36$		B0
28(b)	(6, 0)	B1	
28(c)	<b>Alternative method 1</b>		
	$\frac{6 - \text{their } 0}{0 - \text{their } 6}$ or $\frac{\text{their } 0 - 6}{\text{their } 6 - 0}$ or $\frac{6}{-6}$ or $\frac{-6}{6}$ or $-1$	M1	gradient $AB$
	gradient $OM \times$ gradient $AB = -1$ and gradient $OM = 1$ (and $y = x$ )	A1	must see correct working for M1
	<b>Alternative method 2</b>		
	$\left(\frac{6+0}{2}, \frac{0+6}{2}\right)$ or (3, 3)	M1	coordinates of $M$
gradient $OM = 1$ (and $y = x$ ) or (0, 0) and (3, 3) (and $y = x$ )	A1	must see correct working for M1	

Question	Answer	Mark	Comments
28(d)	$x^2 + x^2 = 36$ or $2x^2 = 36$ or $y^2 + y^2 = 36$ or $2y^2 = 36$ or $(-6) \cos 45^\circ$ or $(-6) \sin 45^\circ$	M1	oe equation
	$(-)\sqrt{\frac{36}{2}}$ or $(-)\sqrt{18}$ or $(-)3\sqrt{2}$ or $(-)\frac{6\sqrt{2}}{2}$ or $(-)\frac{6}{\sqrt{2}}$	M1	
	$(-\sqrt{18}, -\sqrt{18})$ or $(-3\sqrt{2}, -3\sqrt{2})$ or $(-\frac{6\sqrt{2}}{2}, -\frac{6\sqrt{2}}{2})$ or $(-\frac{6}{\sqrt{2}}, -\frac{6}{\sqrt{2}})$	A1	oe surd form
29(a)	$(180, 0)$	B1	
	<b>Additional Guidance</b>		
	Condone degrees symbol on 180		
	Condone $(\pi, 0)$		B1
29(b)	$(-270, 1)$	B1	
	<b>Additional Guidance</b>		
	Condone degrees symbol on 270		
	Condone $(-\frac{3\pi}{2}, 1)$		B1



Question	Answer	Mark	Comments
30(a)	$\frac{1}{81^{\frac{1}{4}}}$ or $\frac{1}{\sqrt[4]{81}}$ or $\sqrt[4]{\frac{1}{81}}$ or $3^{-1}$ or $9^{-\frac{1}{2}}$ or $81^{\frac{1}{4}} = 3$ or $\sqrt[4]{81} = 3$ or $3^4 = 81$	M1	
	$\frac{1}{3}$	A1	
	<b>Additional Guidance</b>		
	3 without $81^{\frac{1}{4}}$ or $\sqrt[4]{81}$		MOA0
30(b)	<b>Alternative method 1</b>		
	$(16 =) 2^4$ or $(2^3)^{2x}$ or $2^{6x}$	M1	oe with consistent base 2
	$(16 =) 2^4$ and $(2^3)^{2x}$ or $2^{6x}$	M1dep	
	$2^{4+6x}$ or $2^{2(2+3x)}$	A1	
	<b>Alternative method 2</b>		
	$((4 \times 8^x)^2 =) (2^2 \times 2^{3x})^2$	M1	
	$(2^{2+3x})^2$	M1dep	
	$2^{4+6x}$ or $2^{2(2+3x)}$	A1	oe index