AQA

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

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 ≤ 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	2^8	B1	
2	ASA	B1	
3	2, 6, 18, 54, 162	B1	
4	b is $\frac{3}{4}$ of a	B1	
5	Any correct product of 36 using a prime factor	M1	2 and 18 2 and 2 and 9 3 and 12 3 and 3 and 4 2 and 3 and 6 May be on a factor tree or repeated division
	2 and 2 and 3 and 3	A1	oe May be on a factor tree or repeated division
	$2^2 \times 3^2$ or $3^2 \times 2^2$	A1	
	Additional Guidance		
	Allow any number of 1s included as factors up to M1A1 only		
	$1 \times 2^2 \times 3^2$		M1A1A0
	$2^2 . 3^2$		M1A1A1
	2 + 2 + 3 + 3		M1A1A0
	$2^2 + 3^2$		M1A1A0
	$2^2 3^2$ or $2^2, 3^2$		M1A1A0
	$2 \times 2 \times 3 \times 3$ and $2^2 \times 3^2$ on answer line but $2 \times 2 \times 3 \times 3 = 2^2 \times 3^2$ on answer line		M1A1A0 M1A1A1
	$2^2 \times 3^2 = 6^4$		M1A1A0
	6×6 with no prime factorisation		M0A0A0

Question	Answer	Mark	Comments
6	False True True True True False	B4	B3 for 5 correct B2 for 4 correct B1 for 3 correct
	Additional Guidance		
	Accept any clear indication as their answer		
7	$162 \times \frac{5}{3}$ or $162 \div \frac{3}{5}$ or 162×5 or 810 or $162 \div 3$ or 54	M1	oe $162 \div 0.6$
	270	A1	
	Additional Guidance		
	For $162 \times \frac{5}{3}$ as a decimal, allow 162×1.66 or better truncation or rounding or 162×1.67 for M1		
	97.2		M0A0

Question	Answer	Mark	Comments
8	$\frac{y}{x} = \frac{5}{8}$ or $\frac{x}{y} = \frac{8}{5}$ or $8y = 5x$ or $\frac{5x}{8}$ or $0.625x$ or $(x =) \frac{8y}{5}$ or $(x =) 1.6y$ or $y = kx$ and $k = \frac{5}{8}$ or $8 \div 5$ incorrectly evaluated and then $y = \frac{x}{\text{their incorrect evaluation}}$	M1	oe
	$y = \frac{5x}{8}$	A1	oe in form $y = f(x)$ or $f(x) = y$ eg $y = 0.625x$ or $y = \frac{x}{1.6}$ or $y = 5x \div 8$ or $y = x \div (8 \div 5)$ or $y = x \div 8 \times 5$
	Additional Guidance		
	$y = \frac{5}{8} \times x$ or $y = \frac{x}{8} \times 5$ or $y = x \div 1.6$		M1A1
	$y8 = x5$ or $(y =) \frac{x5}{8}$ or $(y =) x\frac{5}{8}$ or $y = \frac{5}{8}$ of x		M1A0
	Condone units for M1 only		
	Do not ignore further work eg $y = x \div (8 \div 5)$ then $y = x \div 8 \div 5$		M1A0

9(a)	2 or two	B1	Allow words which imply two times eg double, twice

9(b)	$\div 4$	B1	

Question	Answer	Mark	Comments
10	**Alternative method 1**		
	$2x + x = 18 + 6$	M1	oe Eliminates a variable Implied by $3x = n$, where $n > 18$
	$3x = 24$ or $x = 8$	A1	oe
	$x = 8$ and $y = 2$	A1	
	Alternative method 2		
	$y - -2y = 18 - 2 \times 6$ or $y - -2y = 18 - 12$ or $y + 2y = 18 - 2 \times 6$ or $y + 2y = 18 - 12$	M1	oe Eliminates a variable Implied by $2x - 2y = 12$ followed by $3y = m$, where $m < 18$
	$3y = 6$ or $-3y = -6$ or $y = 2$ or $-y = -2$	A1	oe
	$x = 8$ and $y = 2$	A1	
	Alternative method 3		
	$\frac{18 - y}{2} = y + 6$ or $18 - 2x = x - 6$	M1	oe Eliminates a variable
	$3x = 24$ or $x = 8$ or $3y = 6$ or $y = 2$	A1	oe Collects terms
	$x = 8$ and $y = 2$	A1	

Question	Answer	Mark	Comments
10 cont	**Alternative method 4**		
	Correctly evaluated trial of at least one pair of values in one equation for which they do not work	M1	eg 9 – 2 = 7 The pair of values must not be given as the answer
	Correctly evaluated trial of at least three pairs of values in one equation for which they do not work	M1dep	eg 9 – 2 = 7 2 × 11 + 5 = 27 10 – (–2) = 12 With none of the three pairs of values given as the answer
	$x = 8$ and $y = 2$	A1	
	Additional Guidance		
	One correct value with one incorrect value (or no second value) and no working		M1A1A0
	eg $x = 6$ and $y = 2$		M1A1A0
	eg $y = 2$		M1A1A0
	(8, 2) or 8, 2 on answer line (with or without working)		M1A1A1
	(2, 8) or 2, 8 on answer line with no working		M0A0A0
	Embedded correct values in one equation only eg 2 × 8 + 2 = 18		M1A0A0
	Embedded correct values in both equations ie 2 × 8 + 2 = 18 and 8 – 2 = 6		M1A1A0
	Please check crossed out work, which may indicate correct rejection of a trial in this question, as covered in alternative method 4		

Question	Answer	Mark	Comments
11	**Alternative method 1**		
	4 × 15 or 60 or 2 × 10 or 20 or 80	M1	oe
	$\frac{10}{100}$ × their 80 or 8 or 1.1 and working for first M1 seen	M1dep	oe $\frac{10}{100}$ × their 60 or 6 or 66 or $\frac{10}{100}$ × their 20 or 2 or 22
	their 80 + their 8 or 1.1 × their 80 or 88	M1dep	oe their 60 + their 6 + their 20 + their 2 or 1.1 × their 60 + 1.1 × their 20 or their 66 + their 22
	0.03 × their 88 or 2.64 or their 88 × 1.03	M1dep	oe
	90.64(p)	A1	

Question	Answer	Mark	Comments
11 cont	**Alternative method 2**		
	$\frac{10}{100} \times 15$ or 1.5(0) and $\frac{10}{100} \times 10$ or 1 or 1.1 seen	M1	oe
	15 + their 1.5(0) or 15 × 1.1 or 16.5(0) and 10 + their 1 or 10 × 1.1 or 11	M1dep	oe 27.5(0) implies M2
	their 16.5(0) × 0.03 or 0.495 and their 11 × 0.03 or 0.33 or their 16.5(0) × 1.03 or 16.995 and their 11 × 1.03 or 11.33	M1dep	oe 4 × their 16.5(0) + 2 × their 11 or their 66 + their 22 or 88
	their 0.495 × 4 + their 0.33 × 2 or 1.98 + 0.66 or 2.64 or their 16.995 × 4 or 67.98 and their 11.33 × 2 or 22.66	M1dep	oe 0.03 × their 88 or 2.64 or their 88 × 1.03
	90.64(p)	A1	

Question	Answer	Mark	Comments
11 cont	**Alternative method 3**		
	4 × 15 or 60 or 2 × 10 or 20 or 80	M1	oe
	$\frac{10}{100}$ × their 80 or 8 or $\frac{13}{100}$ × their 80 or 10.4(0) or 1.13 and working for first M1 seen	M1dep	oe $\frac{13}{100}$ × their 60 or 7.8(0) or $\frac{13}{100}$ × their 20 or 2.6(0)
	their 80 + their 10.4(0) or 1.13 × 80 or 90.4(0) **or** 0.03 × their 8 or 0.24	M1dep	oe 60 + their 7.8(0) + 20 + their 2.6(0) or 67.8(0) + 22.6(0)
	their 80 + their 10.4(0) or 1.13 × 80 or 90.4(0) **and** 0.03 × their 8 or 0.24	M1dep	oe
	90.64(p)	A1	

Question	Answer	Mark	Comments
12	$\sqrt{64}$ or 8 or 64 = 8 × 8	M1	Implied by a diameter or side length of 8 stated or shown on the diagram, or radius of 4 stated or used or shown on the diagram
	π × (their 8 ÷ 2)^2 or $\pi \times 4^2$ or $\pi 4^2$ or [50.24, 50.272]	M1dep	oe Allow [3.14, 3.142] for π
	16π	A1	Condone $16 \times \pi$ or $\pi \times 16$ or $\pi 16$
	Additional Guidance		
	$64 - 16\pi$		M1M1A0
	Beware of incorrect methods which lead to the correct answer eg $r = 8$, $2 \times \pi \times 8 = 16\pi$ $\sqrt{64} = 8$, $8^2 = 16$, 16π		M0M0A0 M1M0A0
13	6.005 2(00) × 10^6	B2	B1 for their 6 005 200 written normally and correctly converted to standard form or no number written normally and answer 6.(…) × 10^6
	Additional Guidance		
	(6 500 200 and) 6.500 2(00) × 10^6		B1
	65 200 and 6.52 × 10^4		B1
	10^6 × 6.005 2(00)		B2
	Correct value of 6 005 200 with no conversion to standard form		B0
	6 × 10^6 with no number written normally		B1
14	$x < -2$ or $-2 > x$	B1	
15	3	B1	

Question	Answer	Mark	Comments
16(a)	$\frac{2}{5}$ Even and $\frac{3}{5}$ Odd	B1	oe fractions, decimals or percentages
	Two branches from Even labelled Red $\frac{5}{6}$ Green $\frac{1}{6}$	B1	oe fractions, decimals or percentages Branches from Odd is B0 Allow equivalent labelling eg R and G Green and Not Green
	Additional Guidance		
	In decimals, allow for $\frac{5}{6}$ and $\frac{1}{6}$ 0.83 and 0.17 or 0.833 and 0.167 or 0.834 and 0.166 or 0.84 and 0.16 or better truncation or rounding (sum of pair must equal 1) In percentages, allow for $\frac{5}{6}$ and $\frac{1}{6}$ 83% and 17% or 83.3% and 16.7% or 83.4% and 16.6% or 84% and 16% or better truncation or rounding (sum of pair must equal 100%)		
	Ignore any attempts to combine probabilities to the right of the tree diagram		
16(b)	their $\frac{2}{5}$ × their $\frac{1}{6}$	M1	their P(Even) × their P(Green) ft from (a) if 0 < both probabilities < 1
	$\frac{2}{30}$ or $\frac{1}{15}$	A1ft	oe fraction or decimal ft from (a) if 0 < both probabilities < 1
	Additional Guidance		
	Allow 0.06 or 6% or better truncation or rounding or 0.07 or 7% for $\frac{2}{30}$		
	If the dice branches are not labelled there is no ft from (a)		
	If (a) has no attempt or an incorrect answer full marks can still be gained here for correct working (and answer)		
	Ignore further attempts to simplify or convert to a decimal or percentage after a correct fraction is seen eg $\frac{2}{30} = \frac{1}{10}$ or $\frac{4}{60} = 0.165$		M1A1

Question	Answer	Mark	Comments
17(a)	**Alternative method 1**		
	$\frac{-9--5}{4-2}$ or $\frac{-5--9}{2-4}$ or (2, –5) – (4, –9) = (–2, 4) or (4, –9) – (2, –5) = (2, –4) or $\frac{\text{change in } y}{\text{change in } x}$ or $\frac{\Delta y}{\Delta x}$ or triangle drawn with points *A* and *B* and side lengths of 4 and (–)2 identified or correct explanation of pattern of graph **and** $\frac{-4}{2} = -2$ or $\frac{4}{-2} = -2$	B2	oe fraction eg $\frac{-9+5}{4-2}$ or $\frac{-5+9}{2-4}$ B1 for $\frac{-9--5}{4-2}$ or $\frac{-5--9}{2-4}$ or (2, –5) – (4, –9) = (–2, 4) or (4, –9) – (2, –5) = (2, –4) or $\frac{\text{change in } y}{\text{change in } x}$ or $\frac{\Delta y}{\Delta x}$ or triangle drawn with points *A* and *B* and side lengths of 4 and (–)2 identified or correct explanation of pattern of graph or $\frac{-4}{2} = -2$ or $\frac{4}{-2} = -2$

Question	Answer	Mark	Comments
17(a) cont	**Alternative method 2**		
	Gives $y = -2x + c$ and substitutes (2, –5) or (4, –9) to find $c = -1$ or $y - -5 = -2(x - 2)$ or $y + 5 = -2(x - 2)$ or $y - -9 = -2(x - 4)$ or $y + 9 = -2(x - 4)$ **and** gives $y = -2x - 1$ **and** correctly substitutes and evaluates with the other pair of coordinates to check	B2	B1 for (2, –5) or (4, –9) to find $c = -1$ or $y - -5 = -2(x - 2)$ or $y + 5 = -2(x - 2)$ or $y - -9 = -2(x - 4)$ or $y + 9 = -2(x - 4)$ **or** gives $y = -2x - 1$ and correctly substitutes and evaluates with one or both pair(s) of coordinates
	Alternative method 3		
	$-5 = 2m + c$ and $-9 = 4m + c$ and works out $m = -2$ using a correct algebraic method	B2	oe equations B1 for $-5 = 2m + c$ and $-9 = 4m + c$
	Alternative method 4		
	$-5 = -2(2) + c$ and $-9 = -2(4) + c$ and works out $c = -1$ for both	B2	oe equations B1 for $-5 = -2(2) + c$ and $-9 = -2(4) + c$
	Additional Guidance		
	In alt 1, examples of correct explanation are: 2 left and 4 up 2 right and 4 down		
	In alt 1, points *A* and *B* can be identified on a diagram by their coordinates		
	In alt 2, accept rearrangements of $y = -2x - 1$ eg $2x + y = -1$		
	$\frac{-5-9}{2-4}$ or $\frac{-9-5}{4-2}$ (= –2 or = 2)		B0

Question	Answer	Mark	Comments
17(b)	**Alternative method 1** – uses given point with one from (a) to show gradient = –2		
	$\frac{601--9}{-301-4}$ or $\frac{601--5}{-301-2}$	M1	oe eg $\frac{610}{-305}$ or $\frac{606}{-303}$
	–2 and Yes	A1	Must see working for M1
	Alternative method 2 – correct or no equation shown in (a)		
	Correct method to find $y = -2x - 1$	M1	May be seen in part (a)
	$y = -2x - 1$ and shows that $601 = -2(-301) - 1$ and Yes	A1	
	Alternative method 3 – incorrect equation shown in (a)		
	Substitutes –301 and 601 into their equation from (a)	M1	equation must involve x and y
	Correct evaluation and No	A1ft	
	Alternative method 4 – have gained two marks in (a) by any method		
	uses (2, –5) or (4, –9) to work out $c = -1$	M1	
	$601 = -2(-301) + c$ and $c = -1$ and Yes	A1	
	Alternative method 5 – have shown that $c = -1$ for both points in (a)		
	$601 = -2(-301) + c$	M1	
	$601 = -2(-301) + c$ and $c = -1$ and Yes	A1	
	Additional Guidance		
	$y = -2x - 1$ given in (a) but not used in (b)		M0 for equation
	Correct method in (a) to show that the gradient is –2, but followed by incorrect equation. Incorrect equation then used correctly in (b)		B2 in (a) M1A0 in (b)

Question	Answer	Mark	Comments
18	**Alternative method 1** – price for 8 bottles		
	Any two (including at least one combination) of Single shops Method to work out cost using one shop Shop A 3 × 1 + 5 × 0.5 or 5.5 or 4 × 1 + 4 × 0.5 or 6 or Shop B 4 × 1 + 4 × 0.5 or 6 or 5 × 1 + 3 × 0.5 or 6.5 or Shop C 8 × 0.7 or 5.6 Combinations Method to work out cost using two shops A and B (1 + 2 × 0.5) + (2 × 1 + 3 × 0.5) or 5.5 or B and C (2 × 1 + 3 × 0.5) + (3 × 0.7) or 5.6 or A and C (2 × 1 + 4 × 0.5) + (2 × 0.7) or 5.4 or (1 × 1 + 2 × 0.5) + (5 × 0.7) or 5.5	M2	oe Values may be in £ throughout M1 for any one single shop or combination
	6 bottles from A and 2 bottles from C with M2 awarded	A1	Condone 2 from A and 2 from C with M2 awarded SC2 6 bottles from A and 2 bottles from C with M1M0 awarded SC1 6 bottles from A and 2 bottles from C with M0M0 awarded

Question	Answer	Mark	omments
18 cont	**Alternative method 2** – best average cost per bottle		
	A is $\frac{2}{3}$ or B is 0.7 or C is 0.7	M1	Accept 0.66 or 66(p) or better truncation or rounding or 0.67 or 67(p)
	A is $\frac{2}{3}$ and B is 0.7 and C is 0.7	M1	
	6 bottles from A and 2 bottles from C with M2 awarded	A1	Condone 2 from A and 2 from C with M2 awarded SC2 6 bottles from A and 2 bottles from C with M1M0 awarded SC1 6 bottles from A and 2 bottles from C with M0M0 awarded
	Additional Guidance		
	In both methods, if a price or variable is chosen, values would be the respective multiples of that price or variable		
	For SC2, the M1 may have been awarded for the correct method or price for a different selection of 8 bottles or for the 6 from A and 2 from C eg only working is 6 from A and 2 from C and £5.40		SC2
	Calculations or total costs may not be labelled, but shops may be implied by prices		
	An incorrect evaluation of the total cost of 6 from A and 2 from C leads to a maximum of M1M1A0 Ignore other incorrect evaluations which do not affect the award of marks		

Question	Answer	Mark	Comments
19(a)	(9) 25 45 53 60	B1	cumulative frequencies May be implied by points plotted (± 0.5 square)
	Points plotted with upper class boundaries and cf values (±0.5 square)	B1ft	ft their cumulative frequencies Must be increasing and not a single straight line
	Smooth curve or polygon starting at correct point for their points and going through all their points (±0.5 square)	B1ft	ft their cumulative frequencies Must be increasing and not a single straight line
	Additional Guidance		
	Graphs may start from their first plotted point or from (40, 0) If they have plotted their points at mid-points, with point at (45, 9), their graph may start at (35, 0) Graph starting at (0, 0), but otherwise correct		B1B1B0
	Curve plotted at mid-points or lower class boundaries, but otherwise correct		B1B0B1
	Ignore the graph after $m = 90$		
	Bars drawn as well as correct graph		B1B1B0
	Bars drawn without the correct graph		max B1

Question	Answer	Mark	Comments
19(b)	**Alternative method 1**		
	$60 - 0.2 \times 60$ or 60×0.8 or 48	M1	oe implied by horizontal line from 48 on vertical axis
	Correct reading from their increasing graph	A1ft	$\pm \frac{1}{2}$ square
	Alternative method 2		
	$70 + \frac{3}{8} \times 10$	M1	
	[73, 75]	A1	
	Additional Guidance		
	The correct answer is likely to be [73, 75] from a correct graph		
20	16	B1	
21(a)	Ticks No and gives valid reason	B1	Examples of valid reasons: translation (by $\begin{pmatrix}6\\0\end{pmatrix}$) $\begin{pmatrix}6\\0\end{pmatrix}$ or $\begin{pmatrix}\frac{6}{0}\end{pmatrix}$ or (6, 0) rotation (of 180°), (centre (0, 2.5)) enlargement (of scale factor) –1 (about (0, 2.5))
	Additional Guidance		
	Full descriptions are not needed, but if given must be correct For the enlargement, the scale factor of –1 must be given		
	Transformation (6, 0)		B1
	Moved 6 to the right		B1
	Moved 6 squares		B0
	Condone 'turn' with full description of 180°, (centre) (0, 2.5)		B1
	2 or more single transformations given, with at least 1 correct		B1

Question	Answer	Mark	Comments
21(b)	Enlargement, scale factor –2, centre (–1, 0)	B3	B2 Enlargement, scale factor –2 or enlargement centre (–1, 0) or scale factor –2, centre (–1, 0) B1 (Triangle with) vertices at (0, –1) (0, –3) and (3, –2) or enlargement or scale factor –2 or scale factor 2
	Additional Guidance		
	‘Scale factor’ and ‘centre’ may be implied eg enlargement, –2, (–1, 0)		B3
	Allow ‘–1 on the x-axis’ for (–1, 0)		
	No triangle on diagram, but vertices stated as coordinates and no other marks awarded		B1
	A combination of transformations can score a maximum of 1 mark for the triangle drawn or vertices identified		
	Correct triangle drawn and ‘enlargement’, with no other marks awarded		B1
	Enlargement, (scale factor) $-\frac{1}{2}$, centre (–1, 0)		B2
22	$\frac{QS}{PT}$	B1	

Question	Answer	Mark	Comments
23(a)	[6, 6.5]	B1	
23(b)	**Alternative method 1**		
	$\frac{1}{2} \times (22 + 18) \times (25 - 10)$ or $15 \times 18 + \frac{1}{2} \times 15 \times 4$	M1	oe
	300	A1	
	Alternative method 2		
	20×15	M1	
	300	A1	
	Additional Guidance		
	Alternative method 2 uses average velocity × time		
24(a)	$\frac{7}{2}$	B1	oe improper fraction eg $\frac{14}{4}$
	Additional Guidance		
	Condone ± on numerator and/or denominator		
24(b)	$(16 =) 2^4$ or $(\sqrt[3]{16} =) 16^{\frac{1}{3}}$ or $\sqrt[4]{16} = 2$ or $4^{\frac{2}{3}}$ or $2\sqrt[3]{2}$	M1	oe
	$2^{\frac{4}{3}}$ or $2^{1\frac{1}{3}}$ or $2^{1.\dot{3}}$	A1	
	Additional Guidance		
	$\sqrt[3]{16} = 2^4$ not recovered		M0A0

Question	Answer	Mark	Comments
25	**Alternative method 1** – based on a fraction of the number of males		
	$\frac{1}{4} \times 2x$ (+) $\frac{3}{8} \times x$ or $\frac{7}{8}x$ where x is the number of males	M1	$\frac{1}{4} \times 2$ (+) $\frac{3}{8}$ (× 1) or $\frac{7}{8}$
	$\frac{1}{4} \times 2x + \frac{3}{8} \times x = 84$ or $\frac{7}{8}x = 84$ or $7x = 672$	M1dep	oe $\frac{1}{4} \times 2 + \frac{3}{8}$ (× 1) linked to 84 or $\frac{7}{8}$ linked to 84
	$x = 84 \div$ their $\frac{7}{8}$ or $x = 84 \times$ their $\frac{8}{7}$ or $x = 96$	M1dep	oe dep on M1M1 $84 \div$ their $\frac{7}{8}$ or $84 \times$ their $\frac{8}{7}$ or 96
	288	A1	
	Alternative method 2 - based on a fraction of the number of females		
	$\frac{1}{4} \times y$ (+) $\frac{3}{8} \times \frac{y}{2}$ or $\frac{7}{16}y$ where y is the number of females	M1	$\frac{1}{4}$ (× 1) (+) $\frac{3}{8} \times \frac{1}{2}$ or $\frac{7}{16}$
	$\frac{1}{4} \times y + \frac{3}{8} \times \frac{y}{2} = 84$ or $\frac{7}{16}y = 84$ or $7y = 1344$	M1dep	oe $\frac{1}{4}$ (× 1) + $\frac{3}{8} \times \frac{1}{2}$ linked to 84 or $\frac{7}{16}$ linked to 84
	$y = 84 \div$ their $\frac{7}{16}$ or $y = 84 \times$ their $\frac{16}{7}$ or $y = 192$	M1dep	oe dep on M1M1 $84 \div$ their $\frac{7}{16}$ or $84 \times$ their $\frac{16}{7}$ or 192
	288	A1	

Question	Answer	Mark	Comments
25 cont	**Alternative method 3** – based on a fraction of the total number of people		
	$\frac{1}{4}\times\frac{2}{3}\times z$ or $\frac{4z}{24}$ or $\frac{3}{8}\times\frac{1}{3}\times z$ or $\frac{3z}{24}$ where z is the number of people in the office	M1	oe $\frac{1}{4}\times\frac{2}{3}$ or $\frac{4}{24}$ or $\frac{3}{8}\times\frac{1}{3}$ or $\frac{3}{24}$
	$\frac{1}{4}\times\frac{2}{3}\times z+\frac{3}{8}\times\frac{1}{3}\times z=84$ or $\frac{7z}{24}=84$	M1dep	oe $\frac{3}{8}\times\frac{1}{3}+\frac{1}{4}\times\frac{2}{3}$ linked to 84 or $\frac{7}{24}$ linked to 84
	$z = 84 \div$ their $\frac{7}{24}$ or $z = 84 \times$ their $\frac{24}{7}$ or $7z = 2016$	M1dep	oe dep on M1M1 $84 \div$ their $\frac{7}{24}$ or $84 \times$ their $\frac{24}{7}$
	288	A1	
	Alternative method 4 – chooses numbers of females and males and factors up or down		
	Chooses numbers for females and males in the ratio 2 : 1 and works out the numbers of females and males wearing glasses (which should be in the ratio 4 : 3)	M1	eg 32 females and 16 males and $\frac{1}{4}\times 32$ (+) $\frac{3}{8}\times 16$ or 8 and 6 or 14
	Works out multiplying factor by 84 ÷ their total number of people wearing glasses	M1dep	eg $84 \div (\frac{1}{4}\times 32 + \frac{3}{8}\times 16)$ or $84 \div 14$ (= 6)
	Multiplies their total of females and males by their multiplying factor	M1dep	eg 32 × their 6 + 16 × their 6 or (32 + 16) × their 6
	288	A1	
	Additional Guidance		
	If more than one method is attempted: if an answer is given, mark the method leading to that answer if no answer is given, mark each method and award the best mark		

Question	Answer	Mark	Comments
26	**Alternative method 1**		
	$4x^2 + 6xy + 6xy + 9y^2$	M1	oe Allow one error Implied by $4x^2 + 12xy + ...$ or $... + 12xy + 9y^2$
	$4x^2 + 6xy + 6xy + 9y^2$ or $4x^2 + 12xy + 9y^2$	A1	oe Fully correct
	$4x^3 + 6x^2y + 6x^2y + 9xy^2$ or $4x^3 + 12x^2y + 9xy^2$ or $-16x^2 - 24xy - 24xy - 36y^2$ or $-16x^2 - 48xy - 36y^2$	M1dep	oe ft correct multiplication of their expansion by x or by -4 if their expansion for first M1 has at least 3 terms after simplification
	$4x^3 + 12x^2y + 9xy^2 - 16x^2 - 48xy - 36y^2$	A1ft	ft M1A0M1 if their first expansion has at least 3 terms after simplification
	Alternative method 2		
	$2x^2 + 3xy - 8x - 12y$	M1	oe Allow one error eg $2x^2 + 3xy - 8x + 12y$
	$2x^2 + 3xy - 8x - 12y$	A1	oe Fully correct
	$4x^3 + 6x^2y - 16x^2 - 24xy$ or (+) $6x^2y + 9xy^2 - 24xy - 36y^2$	M1dep	oe ft correct multiplication of their expansion by $2x$ or by $3y$ if their expansion for first M1 has at least 3 terms after simplification
	$4x^3 + 12x^2y + 9xy^2 - 16x^2 - 48xy - 36y^2$	A1ft	ft M1A0M1 if their first expansion has at least 3 terms after simplification
	Additional Guidance		
	Terms and variables may be in any order for M and A marks		
	For M1 A1 M1dep terms may be seen in a grid		
	$4x^3 - 16x^2 + 9xy^2 - 36y^2$ from $(x - 4)(4x^2 + 9y^2)$		M0A0M0A0
	In alt 2, condone $(2x^2 + 3xy - 8x - 12y)^2$ for M1A1 only		
	One error can be one incorrect term or a missing or extra term		
	Do not ignore fw when awarding the final A mark		
	If $(x - 4)(2x + 3y)$ and $(2x + 3y)^2$ are both attempted and no answer is given, mark both and award the better mark		

Question	Answer	Mark	Comments
27	$\frac{4-0}{-1-0}$ or –4	M1	oe
	–1 ÷ their –4 or $\frac{1}{4}$	M1	oe their –4 must be their gradient of OP
	y – 4 = their $\frac{1}{4}(x - -1)$ or 4 = their $\frac{1}{4}(-1) + c$	M1dep	oe dep on second M1 oe c = 4.25
	$y = \frac{1}{4}x + \frac{17}{4}$ or $y = 0.25x + 4.25$	A1	oe eg $y = 0.25x + 4\frac{1}{4}$ Accept $y = \frac{x+17}{4}$
	Additional Guidance		
	An answer of $4y = x + 17$, with or without the correct answer seen		M1M1M1A0
	For A1, allow a mixture of fractions, decimals and mixed numbers		
	$y - y_1 = m(x - x_1)$ stated, followed by $y - 4 = \frac{1}{4}(x - -1)$ oe		M1M1M1

Question	Answer	Mark	Comments
28	**Alternative method 1**		
	$\frac{1}{3}$ (×) π (×) 5^2 (×) 15 or 125π or [392.5, 392.8]	M1	oe
	$\frac{r}{5} = \frac{15-9}{15}$ or $r = 2$	M1	oe r is radius of small cone
	$\frac{1}{3}$ × π × their 2^2 × (15 – 9) or 8π or [25.12, 25.14]	M1dep	dep on 2nd M1
	117π	A1	Accept $\pi 117$ or $\frac{351\pi}{3}$
	Alternative method 2		
	$\frac{1}{3}$ (×) π (×) 5^2 (×) 15 or 125π or [392.5, 392.8]	M1	oe
	volume sf = $\left(\frac{15-9}{15}\right)^3$ or $\frac{8}{125}$ or $\left(\frac{15}{15-9}\right)^3$ or $\frac{125}{8}$	M1	oe
	their 125π × their $\frac{8}{125}$ or their 125π ÷ their $\frac{125}{8}$ or 8π or [25.12, 25.14]	M1dep	dep on 2nd M1 Accept 1 – $\frac{8}{125}$ or $\frac{117}{125}$
	117π	A1	Accept $\pi 117$ or $\frac{351\pi}{3}$
	Additional Guidance		
	Allow [3.14, 3.142] for π for M marks only		
	Answer of 367.(…)		M1M1M1A0

Question	Answer	Mark	Comments
29	sin 45 = $\frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ or tan 45 = 1 or $\frac{1}{1}$ or tan 60 = $\sqrt{3}$ or $\frac{\sqrt{3}}{1}$	B1	oe stated or in correct place in expression or implied by multiplier of 2 or 4
	sin 45 = $\frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ and tan 45 = 1 or $\frac{1}{1}$ and tan 60 = $\sqrt{3}$ or $\frac{\sqrt{3}}{1}$	B1	oe stated or in correct place in expression or implied by multiplier of 2 or 4 eg $\frac{2\times\frac{1}{\sqrt{2}}-1}{4\times\frac{\sqrt{3}}{1}}$
	$\frac{\sqrt{2}-1}{4\sqrt{3}}\times\frac{\sqrt{3}}{\sqrt{3}}$	M1	oe rationalisation of their denominator eg $\frac{\frac{2}{\sqrt{2}}-1}{4\sqrt{3}}\times\frac{4\sqrt{3}}{4\sqrt{3}}$
	$\frac{\sqrt{6}-\sqrt{3}}{12}$	A1	oe in the form $\frac{\sqrt{6a^2}-\sqrt{3a^2}}{12a}$ where a is a positive integer eg $\frac{\sqrt{24}-\sqrt{12}}{24}$ (when $a = 2$)
	Additional Guidance		
	$\frac{2\times\frac{1}{\sqrt{2}}-1}{4\sqrt{3}}$ or $\frac{\sqrt{2}-1}{4\sqrt{3}}$ or $\frac{\sqrt{2}-1}{\sqrt{48}}$	B1B1	
	$\frac{\sqrt{48}(\sqrt{2}-1)}{\sqrt{48}\sqrt{48}}$ or $\frac{\sqrt{48}(\sqrt{2}-1)}{48}$	B1B1M1	
	$\frac{\sqrt{96}-\sqrt{48}}{48}$	B1B1M1A1	
	B1B1 awarded, incorrect simplification, then correct method to rationalise	B1B1M1	