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# GCSE Mathematics

Paper 1 Higher Tier

Mark scheme

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Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [aqa.org.uk](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	$2^8$	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	
	<b>Additional Guidance</b>		
	Allow any number of 1s included as factors up to M1A1 only		
	$1 \times 2^2 \times 3^2$		M1A1A0
	$2^2 \cdot 3^2$		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	
$6 \times 6$ 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	
	<b>Additional Guidance</b>			
	Accept any clear indication as their answer			
7	$162 \times \frac{5}{3}$ or $162 \div \frac{3}{5}$ or $162 \times 5$ or 810 or $162 \div 3$ or 54	M1	oe $162 \div 0.6$	
	270		A1	
	<b>Additional Guidance</b>			
	For $162 \times \frac{5}{3}$ as a decimal, allow $162 \times 1.66$ or better truncation or rounding or $162 \times 1.67$ for M1			
	97.2	MOA0		

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 $y = x \div 8 \times 5$
	<b>Additional Guidance</b>		
	$y = \frac{5}{8} \times x$ 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
<b>10</b>	<b>Alternative method 1</b>		
	$2x + x = 18 + 6$	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	
	<b>Alternative method 2</b>		
	$y - -2y = 18 - 2 \times 6$ 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	
	<b>Alternative method 3</b>		
	$\frac{18 - y}{2} = y + 6$ 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
<b>10 cont</b>	<b>Alternative method 4</b>		
	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 $9 - 2 = 7$ $2 \times 11 + 5 = 27$ $10 - (-2) = 12$ With none of the three pairs of values given as the answer
	$x = 8$ and $y = 2$	A1	
	<b>Additional Guidance</b>		
	One correct value with one incorrect value (or no second value) and no working eg $x = 6$ and $y = 2$ eg $y = 2$		M1A1A0  M1A1A0 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 $2 \times 8 + 2 = 18$ Embedded correct values in both equations ie $2 \times 8 + 2 = 18$ and $8 - 2 = 6$		M1A0A0  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
<b>11</b>	<b>Alternative method 1</b>		
	$4 \times 15$ or 60 or $2 \times 10$ or 20 or 80	M1	oe
	$\frac{10}{100} \times$ their 80 or 8 or 1.1 and working for first M1 seen	M1dep	oe $\frac{10}{100} \times$ their 60 or 6 or 66 or $\frac{10}{100} \times$ their 20 or 2 or 22
	their 80 + their 8 or $1.1 \times$ their 80 or 88	M1dep	oe their 60 + their 6 + their 20 + their 2 or $1.1 \times$ their 60 + $1.1 \times$ their 20 or their 66 + their 22
	$0.03 \times$ their 88 or 2.64 or their 88 $\times 1.03$	M1dep	oe
	90.64(p)	A1	

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

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

Question	Answer	Mark	Comments
12	$\sqrt{64}$ or 8 or $64 = 8 \times 8$	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
	$\pi \times (\text{their } 8 \div 2)^2$ or $\pi \times 4^2$ or $\pi 4^2$ or [50.24, 50.272]	M1dep	oe Allow [3.14, 3.142] for $\pi$
	$16\pi$	A1	Condone $16 \times \pi$ or $\pi \times 16$ or $\pi 16$
	<b>Additional Guidance</b>		
	$64 - 16\pi$		M1M1A0
	Beware of incorrect methods which lead to the correct answer eg $r = 8, 2 \times \pi \times 8 = 16\pi$ $\sqrt{64} = 8, 8^2 = 16, 16\pi$		M0M0A0 M1M0A0
13	$6.005\ 2(00) \times 10^6$	B2	B1 for their 6 005 200 written normally and correctly converted to standard form or no number written normally and answer $6(\dots) \times 10^6$
	<b>Additional Guidance</b>		
	(6 500 200 and) $6.500\ 2(00) \times 10^6$		B1
	65 200 and $6.52 \times 10^4$		B1
	$10^6 \times 6.005\ 2(00)$		B2
	Correct value of 6 005 200 with no conversion to standard form		B0
	$6 \times 10^6$ 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
	<b>Additional Guidance</b>		
	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 $\frac{2}{5}$ x their $\frac{1}{6}$	M1	their P(Even) x their P(Green) ft from (a) if $0 < \text{both probabilities} < 1$
	$\frac{2}{30}$ or $\frac{1}{15}$	A1ft	oe fraction or decimal ft from (a) if $0 < \text{both probabilities} < 1$
	<b>Additional Guidance</b>		
	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 $\frac{2}{30} = \frac{1}{15}$ or $\frac{4}{60} = 0.165$		M1A1	

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

Question	Answer	Mark	Comments
17(a) cont	<b>Alternative method 2</b>		
	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 $y + 9 = -2(x - 4)$ <b>and</b> gives $y = -2x - 1$ <b>and</b> 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 $y + 9 = -2(x - 4)$ <b>or</b> gives $y = -2x - 1$ and correctly substitutes and evaluates with one or both pair(s) of coordinates
	<b>Alternative method 3</b>		
	$-5 = 2m + c$ and $-9 = 4m + c$ and works out $m = -2$ using a correct algebraic method	B2	oe equations B1 for $-5 = 2m + c$ and $-9 = 4m + c$
	<b>Alternative method 4</b>		
	$-5 = -2(2) + c$ and $-9 = -2(4) + c$ and works out $c = -1$ for both	B2	oe equations B1 for $-5 = -2(2) + c$ and $-9 = -2(4) + c$
	<b>Additional Guidance</b>		
	In alt 1, examples of correct explanation are: 2 left and 4 up 2 right and 4 down		
In alt 1, points <i>A</i> and <i>B</i> 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
<b>17(b)</b>	<b>Alternative method 1</b> – 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
	<b>Alternative method 2</b> – 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	
	<b>Alternative method 3</b> – 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	
	<b>Alternative method 4</b> – 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	
	<b>Alternative method 5</b> – 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	
	<b>Additional Guidance</b>		
$y = -2x - 1$ 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	<p><b>Alternative method 1 – price for 8 bottles</b></p> <p>Any two (including at least one combination) of</p> <p>Single shops</p> <p>Method to work out cost using one shop</p> <p>Shop A  <math>3 \times 1 + 5 \times 0.5</math> or 5.5                      or <math>4 \times 1 + 4 \times 0.5</math> or 6                      or</p> <p>Shop B  <math>4 \times 1 + 4 \times 0.5</math> or 6                      or <math>5 \times 1 + 3 \times 0.5</math> or 6.5                      or</p> <p>Shop C  <math>8 \times 0.7</math> or 5.6</p> <p>Combinations</p> <p>Method to work out cost using two shops</p> <p>A and B  <math>(1 + 2 \times 0.5) + (2 \times 1 + 3 \times 0.5)</math> or 5.5                      or</p> <p>B and C  <math>(2 \times 1 + 3 \times 0.5) + (3 \times 0.7)</math> or 5.6                      or</p> <p>A and C  <math>(2 \times 1 + 4 \times 0.5) + (2 \times 0.7)</math> or 5.4                      or</p> <p><math>(1 \times 1 + 2 \times 0.5) + (5 \times 0.7)</math> or 5.5</p>	M2	<p>oe</p> <p>Values may be in £ throughout</p> <p>M1 for any one single shop or combination</p>
	<p>6 bottles from A and 2 bottles from C with M2 awarded</p>		A1

Question	Answer	Mark	Comments
18 cont	<b>Alternative method 2</b> – 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
<b>Additional Guidance</b>			
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
	<b>Additional Guidance</b>		
	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)	<b>Alternative method 1</b>		
	60 – 0.2 × 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
	<b>Alternative method 2</b>		
	$70 + \frac{3}{8} \times 10$	M1	
	[73, 75]	A1	
	<b>Additional Guidance</b>		
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 $\begin{pmatrix} 6 \\ 0 \end{pmatrix}$ or (6, 0) rotation (of 180°), (centre (0, 2.5)) enlargement (of scale factor) –1 (about (0, 2.5))
	<b>Additional Guidance</b>		
	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
	<b>Additional Guidance</b>		
	'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)	<b>Alternative method 1</b>		
	$\frac{1}{2} \times (22 + 18) \times (25 - 10)$ or $15 \times 18 + \frac{1}{2} \times 15 \times 4$	M1	oe
	300	A1	
	<b>Alternative method 2</b>		
	$20 \times 15$	M1	
	300	A1	
	<b>Additional Guidance</b>		
	Alternative method 2 uses average velocity $\times$ time		
24(a)	$\frac{7}{2}$	B1	oe improper fraction eg $\frac{14}{4}$
	<b>Additional Guidance</b>		
	Condone $\pm$ 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 $2^{1.3}$	A1	
	<b>Additional Guidance</b>		
	$\sqrt[3]{16} = 2^4$ not recovered		M0A0

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



Question	Answer	Mark	Comments
<b>25 cont</b>	<b>Alternative method 3</b> – 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
	$z = 84 \div \text{their } \frac{7}{24}$ or $z = 84 \times \text{their } \frac{24}{7}$ or $7z = 2016$	M1dep	oe dep on M1M1 $84 \div \text{their } \frac{7}{24}$ or $84 \times \text{their } \frac{24}{7}$
	288	A1	
	<b>Alternative method 4</b> – 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 $84 \div \text{their total number of people wearing glasses}$	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 $32 \times \text{their } 6 + 16 \times \text{their } 6$ or $(32 + 16) \times \text{their } 6$
	288	A1	
<b>Additional Guidance</b>			
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
<b>26</b>	<b>Alternative method 1</b>		
	$4x^2 + 6xy + 6xy + 9y^2$	M1	oe Allow one error Implied by $4x^2 + 12xy + \dots$ or $\dots + 12xy + 9y^2$
	$4x^2 + 6xy + 6xy + 9y^2$ 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
	<b>Alternative method 2</b>		
	$2x^2 + 3xy - 8x - 12y$	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
	<b>Additional Guidance</b>		
	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
	$-1 \div$ 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 $y = \frac{x+17}{4}$
	<b>Additional Guidance</b>		
	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	<b>Alternative method 1</b>		
	$\frac{1}{3} (\times) \pi (\times) 5^2 (\times) 15$ or $125\pi$ 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
	$\frac{1}{3} \times \pi \times \text{their } 2^2 \times (15-9)$ or $8\pi$ or [25.12, 25.14]	M1dep	dep on 2nd M1
	$117\pi$	A1	Accept $\pi 117$ or $\frac{351\pi}{3}$
	<b>Alternative method 2</b>		
	$\frac{1}{3} (\times) \pi (\times) 5^2 (\times) 15$ or $125\pi$ 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 $125\pi \times$ their $\frac{8}{125}$ or their $125\pi \div$ their $\frac{125}{8}$ or $8\pi$ or [25.12, 25.14]	M1dep	dep on 2nd M1 Accept $1 - \frac{8}{125}$ or $\frac{117}{125}$
	$117\pi$	A1	Accept $\pi 117$ or $\frac{351\pi}{3}$
	<b>Additional Guidance</b>		
	Allow [3.14, 3.142] for $\pi$ 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 $a = 2$ )
	<b>Additional Guidance</b>		
	$\frac{2 \times \frac{1}{\sqrt{2}} - 1}{4\sqrt{3}}$ 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