



GCSE MATHEMATICS 8300/3H

Higher Tier

Paper 3 Calculator

Shadow paper based on November 2021 paper

Mark scheme

Version: 1.0

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 Examiner.

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.

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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.

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

Examiners should consistently apply the following principles

Diagrams

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

Responses which appear to come from incorrect methods

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

Questions which ask students to show working

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

Questions which do not ask students to show working

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

Misread or miscopy

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

Further work

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

Choice

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

Work not replaced

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

Work replaced

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

Premature approximation

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

Continental notation

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

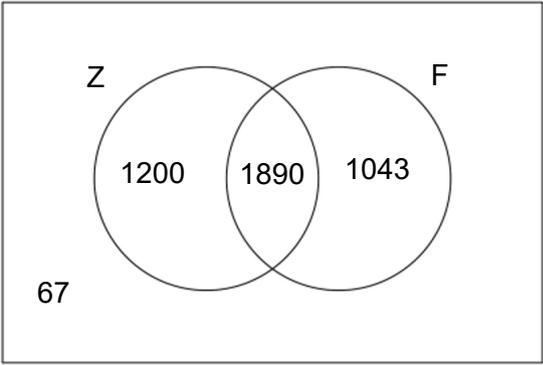
Q	Answer	Mark	Comments
1	$b = \sqrt{a} - 4$	B1	

Q	Answer	Mark	Comments
2	0.656	B1	

Q	Answer	Mark	Comments
3	$\left(0, -\frac{3}{4}\right)$	B1	

Q	Answer	Mark	Comments
4	$(y + 9)(y - 9)$	B1	

Q	Answer	Mark	Comments
5	$8 \times 5 - (3 + 7 + 12)$ or $40 - 22$ or 18	M1	implied by two numbers with a total of 18 eg 8 and 10
	2 or 13	A1	le a number that could give a range of 10. Ignore other numbers that would alter the range eg 2 with 16
	5 and 13	B1	
	Additional Guidance		
	5 and 13 is the only fully correct answer		M1A1B1
	2,16		M1A1B0

Q	Answer	Mark	Comments
	4200 × 0.45 or 1890	M1	oe implied by 51 975
	$4200 \times \frac{2}{7}$ or 1200	M1	oe implied by 21 600
	4200 – their 1680 – their 1200 – 67 or 1043	M1	oe implied by 17 731
	their 1890 × 27.5 + their 1200 × 18 + their 1043 × 17 or 51 975 + 21 600 + 17 731	M1	
	91 306	A1	
Additional Guidance			
6	Method marks may be awarded for correct work seen on Venn diagram or in working, with no or incorrect answer, even if this is seen amongst multiple attempts		
	For the 4 th method mark, incorrectly placed values from their Venn diagram may be used or values connected to the correct category eg if zoo only and fair only values transposed on the Venn diagram accept their 1890 × 27.5 + their 1200 × 18 + their 1043 × 17		
<div style="display: flex; align-items: center;"> ξ  </div>			

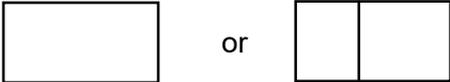
Q	Answer	Mark	Comments
7	$312 \div (3.8 + 1)$ or $312 \div 4.8$ or 65 or $\frac{3.8}{(3.8+1)}$ or $\frac{3.8}{4.8}$ or 0.79(...) or $3.8 - 1$ or 2.8	M1	oe
	their 65×3.8 or $312 - \text{their } 65$ or 247 or $312 \times \text{their } 0.79(\dots)$ or their $65 \times (3.8 - 1)$ or their $65 \times \text{their } 2.8$ or $\frac{\text{their } 2.8}{3.8+1}$ or 0.58(...)	M1dep	oe
	182	A1	
	Additional Guidance		
	247 and 65		M1M1
	$312 \div 3.8$		M0

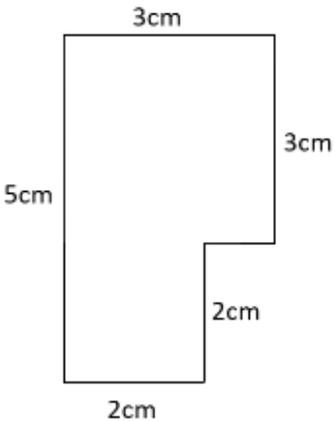
Q	Answer	Mark	Comments
8	Alternative method 1		
	258 × 0.45 or 116.1	M1	
	their 116.1 ÷ 6.25	M1	their 116.1 must come from a division or multiplication using 258 and 0.45 only
	18.576 or 18.58 or 18.6	A1	SC1 725.625 or 725.63 or 725.6 or 91.73
	Alternative method 2		
	258 ÷ 6.25 or 41.28	M1	
	their 41.28 × 0.45	M1	their 41.28 must come from a division or multiplication using 198 and 6.25 only
	18.576 or 18.58 or 18.6	A1	SC1 725.625 or 725.63 or 725.6 or 91.73
	Alternative method 3		
	0.45 ÷ 6.25 or 0.072	M1	
	258 × their 0.072	M1dep	
	18.576 or 18.58 or 18.6	A1	SC1 725.625 or 725.63 or 725.6 or 91.73
	Alternative method 4		
	6.25 ÷ 0.45 or 13.8 or 13.8(...) or 13.9	M1	
	258 ÷ their 13.8	M1dep	
	18.576 or 18.58 or 18.6	A1	SC1 725.625 or 725.63 or 725.6 or 91.73

Additional guidance for this question is on the next page

		Additional Guidance	
8 cont		$258 \times 0.45 \div 6.25$ oe	M1M1
		$258 \times 0.45 \times 6.25$ (which gives 725.625)	M1M0
		$258 \div 0.45 \div 6.25$ (which gives 91.73)	M0M1
		$258 \div 0.45 \times 6.25$ (which gives 3583.3)	M0M0
		Do not allow 6.25^2 for 6.25 eg $258 \div 6.25 \div 6.25$	M0
		Ignore rounding or truncation after correct answer seen	

Q	Answer	Mark	Comments
9	$(x =) 3 \times 4$ or $(x =) 12$ or area of top right rectangle is 12×5 or $15 \div 3 \times \text{their } 12$ or 60 or area of bottom left rectangle is $120 \div 4$ or $360 \div \text{their } 12$ or 30	M1	may be on diagram implied by length of bottom left or bottom right vertical section is 10
	Area of top right rectangle is 12×5 or $15 \div 3 \times \text{their } 12$ or 60 and area of bottom left rectangle is $120 \div 4$ or $360 \div \text{their } 12$ or 30 or Total area is $(3 + \text{their } 12) \times (15 \div 3 + 120 \div \text{their } 12)$ or 15×15 or 225	M1dep	may be on diagram
	(Total shaded area is $60 + 30$) $= 90$ (Total shaded area is $225 - 135$) $= 90$	A1	implied by $90 : 135$
	$2 : 3$ or $1 : \frac{3}{2}$	B1ft	ft simplification of their ratio or conversion into the form $1 : n$ with M2A0 or M1M0A0 scored
	Additional Guidance		
	If their ratio cannot be simplified by dividing by a common factor they can only score B1ft by converting into the form $1 : n$ or $n : 1$		
	$\frac{90}{225} : \frac{135}{225}$		M1M1A1B0
	135 : 90 simplified to 3 : 2		M1M1A0B1ft
	2 cm ² : 3 cm ²		M1M1A1B0
For B1, accept values as decimals rounded or truncated to 2 dp or better eg $1 : 1.5$ or $0.666 : 1$		B1	

Q	Answer	Mark	Comments
10(a)	Rectangle with horizontal sides 5 cm and vertical sides 2 cm	B1	accept internal vertical line 2 cm from the left, but no other internal lines
	Additional Guidance		
	 with dimensions 5 cm and 2 cm	B1	
	Do not accept other internal lines		
Mark intention			

Q	Answer	Mark	Comments
10(b)		B1	any orientation
	Additional Guidance		
	Do not accept internal lines		
	Do not accept a reflection		
	Mark intention		

Q	Answer	Mark	Comments
11	31 or 37	B1	implied by correct answer
	$\frac{31}{121} (\times 100)$ or $\frac{37}{121} (\times 100)$ or $\frac{\text{their number}}{121} (\times 100)$ or their number = $\frac{121x}{100}$	M1	oe their number can be any integer value
	25.6(...) or 30.6 or 30.58 or 30.579 or 30.5785(...) or correct evaluation of their number as a percentage of 121	A1ft	ft B0M1 oe their number must be an integer [20, 30] or any prime number
	Additional Guidance		
	25.6(...) or 30.6 (or 30.58 or 30.579 or 30.5785(...))	B1M1A1	
	25.6(...) and 30.6 (or 30.58 or 30.579 or 30.5785(...))	B1M1A1	
	31 or 37 must be clearly indicated as their prime number		
	Any integer [20, 30] used can score B0M1A1ft eg $25 \div 121 \times 100$ with answer 20.7	B0M1A1ft	
Any prime number used can score B0M1A1ft eg $7 \div 121 \times 100$ with answer 5.8 or 5.79 or 5.785(...)	B0M1A1ft		

Q	Answer	Mark	Comments
12	360 ÷ 20 or 18 or (20 – 2) × 180 or 3240	M1	oe may be seen on diagram
	162	A1	

Q	Answer	Mark	Comments
13	Alternative method 1		
	$5 \times 28 \times 17$ or 2380	M1	
	$\pi \times (28 \div 2)^2 \times 17 (\div 2)$ or $\pi \times 14^2 \times 17 (\div 2)$ or $3332 \pi (\div 2)$ or $\pi \times (28 \div 2)^2 \div 2 (\times 17)$ or $\pi \times 14^2 \div 2 (\times 17)$ or $\frac{196\pi}{2} (\times 17)$ or $98 \pi (\times 17)$ or $[307.7, 307.9\dots] (\times 17)$ or $[10\,462, 10\,469] (\div 2)$	M1	oe accept [3.14, 3.142] for π
	$\frac{3332\pi}{2}$ or 1666π or $[5231.2, 5234.5]$	M1dep	dep on previous mark
	[7611, 7614]	A1	
	Alternative method 2		
	5×28 or 140	M1	
	$\pi \times (28 \div 2)^2 \div 2$ or $\pi \times 14^2 \div 2$ or $\frac{196\pi}{2}$ or $[307.7, 307.9\dots]$	M1	accept [3.14, 3.142] for π
	(their 140 + their $\frac{196\pi}{2}$) $\times 17$ or $[307.7, 307.9\dots] \times 17$	M1dep	dep on M1M1
	[7611, 7614]	A1	

Q	Answer	Mark	Comments
14	Alternative method 1		
	13.8×0.85 or 11.73	M1	oe
	$13.8(0) \div 1.15$ or 12	M1	oe
	11.73 and 12 and No	A1	
	Alternative method 2		
	1.15 or 0.85 seen	M1	
	1.15×0.85 or 0.9775	M1dep	
	0.9775 and No	A1	oe 1% decrease and No
	Alternative method 3		
	13.8×0.85 or 11.73	M1	
	their 11.73×1.15 or 13.48(95)	M1dep	
	13.49 and No	A1	accept 13.48 or 13.49
	Additional Guidance		
	$12 \times 1.15 = 13.80$, $13.8 \times 0.85 = 11.73$ and No		
$13.8 \times 1.15 = 15.87$, $15.87 \times 0.85 = 13.4895$ and No			M0M0A0

Q	Answer	Mark	Comments	
15	$3.3k + 6k - 0.25 + 0.7k = 1$	M1	oe eg $10k - 0.25 = 1$	
	$k = 0.125$	A1	oe	
	0.5	A1ft	oe eg $\frac{100}{200}$ or 50%	
	Additional Guidance			
	Accept working in percentages			
	$10k - 0.25 = 1$, $10k = 0.75$, $k = 0.075$			M1A0A1ft
$10k + 0.25 = 1$, $10k = 0.75$, $k = 0.075$			M0A0A0	

Q	Answer	Mark	Comments	
16	(Gradient of $PQ =$) $\frac{15-12}{6-8}$ or $\frac{12-15}{8-6}$ or -1.5 or $\frac{3}{-2}$ or (gradient of $QR =$) $\frac{12-10}{8-5}$ or $\frac{10-12}{5-8}$ or $\frac{2}{3}$ or $\frac{-2}{-3}$	M1	oe	
	(Gradient of $PQ =$) -1.5 or $\frac{3}{-2}$ and (gradient of $QR =$) $\frac{2}{3}$ or $\frac{-2}{-3}$	M1dep	oe	
	Yes and $-1.5 \times \frac{2}{3} = -1$ or Yes and $\frac{3}{-2} \times \frac{2}{3} = -1$	A1ft	oe ft their two gradients with M1 scored accept Yes and -1.5 is the negative reciprocal of $\frac{2}{3}$	
	Additional Guidance			
	Accept $-\frac{3}{2}$ or $\frac{3}{-2}$ for $\frac{-3}{2}$			
	Gradient of $PQ = \frac{3}{-2}$, gradient of $QR = \frac{2}{3}$, Yes and $\frac{3}{-2} \times \frac{2}{3} = -1$			M1M0A1ft
Answers involving Pythagoras' theorem or scale drawing			M0M0A0	

Q	Answer	Mark	Comments
17	$-\frac{13}{2}$	B1	

Q	Answer	Mark	Comments
18	x^2	B1	

Q	Answer	Mark	Comments
19	$2\sqrt{17}$	B1	

Q	Answer	Mark	Comments
20	$b = 3c$ or $b = 18$ or $\frac{a}{b} \times \frac{b}{c} = 5c \times 3$	M1	oe eg $\frac{a}{5c} = b$ or $\frac{a}{18} = 5c$
	$(a =) 15c^2$ or $5 \times 6 \times 3 \times 6$ or 30×18	M1dep	oe
	540	A1	
	Additional Guidance		
	$\frac{b}{6} = 3$		M0
	$\frac{a}{b} = 30$		M0

Q	Answer	Mark	Comments
21	(Class widths are) 20, 5, 10, 15	M1	
	20 ÷ 20 or 1.0 or 23 ÷ 5 or 4.6 or 27 ÷ 10 or 2.7 or 33 ÷ 15 or 2.2	M1	implied by correct bar
	Any three of 20 ÷ 20 or 1.0 and 23 ÷ 5 or 4.6 and 27 ÷ 10 or 2.7 and 33 ÷ 15 or 2.2	M1dep	implied by correct bars
	All bars correct	A1	$\pm \frac{1}{2}$ square
	Additional Guidance		
	Four correct frequency density values imply first M1		

Q	Answer	Mark	Comments
22	$\frac{n+1}{3n+1}$	B3	oe eg $\frac{n+1}{2n+n+1}$ B2 any two correct n th terms from $2n$ or $n+1$ or $3n+1$ B1 any one correct n th term from $2n$ or $n+1$ or $3n+1$
	Additional Guidance		
	May be seen in a fraction or added eg $2n + (n+1)$		B2
	Do not accept $2n$ embedded in an incorrect expression eg $2n - 2$		B0

Q	Answer	Mark	Comments
23(a)	(2, 81)	B1	

Q	Answer	Mark	Comments
23(b)	$-\frac{1}{2}$	B1	accept $(-\frac{1}{2}, \frac{1}{3})$
	Additional Guidance		
	$3^{-1} = \frac{1}{3}$		B0

Q	Answer	Mark	Comments
24	Any correct pair of values	B1	eg $a = 25 \quad b = \frac{1}{2}$ $a = 125 \quad b = \frac{1}{3}$ $a = 625 \quad b = \frac{1}{4}$
	Additional Guidance		
	$a = 25 \quad b = \frac{1}{3}$		B0
	$a = 25 \quad b = \frac{1}{1}$		B0
	$a = 25 \quad b = 1$		B0

Q	Answer	Mark	Comments
25	Alternative method 1 – multiplies $(2x + 2)(x - 3)$ first		
	$2x^2 - 6x + 2x - 6$ or $2x^2 - 4x - 6$	M1	four terms with at least three correct implied by $2x^2 - 4x \pm k$ where k is a non-zero constant
	$2x^3 - 8x^2 + 2x^2 - 8x - 6x^2 + 24x - 6x + 24$ or $2x^3 - 4x^2 - 6x - 8x^2 + 16x + 24$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and -4
	$2x^3 - 12x^2 + 10x + 24$	A1	
	Alternative method 2 – multiplies $(x - 3)(x - 4)$ first		
	$x^2 - 4x - 3x + 12$ or $x^2 - 7x + 12$	M1	four terms with at least three correct implied by $x^2 - 7x \pm k$ where k is a non-zero constant
	$2x^3 - 8x^2 - 6x^2 + 24x + 2x^2 - 8x - 6x + 24$ or $2x^3 - 8x^2 + 16x - 4x^2 - 6x + 24$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by $2x$ and $+2$
	$2x^3 - 12x^2 + 10x + 24$	A1	
	Alternative method 3 – multiplies $(2x + 2)(x - 4)$ first		
	$2x^2 + 2x - 8x - 8$ or $2x^2 - 6x - 8$	M1	four terms with at least three correct implied by $2x^2 - 6x \pm k$ where k is a non-zero constant
	$2x^3 + 2x^2 - 8x^2 - 8x - 6x^2 - 6x + 24x - 24$ or $2x^3 - 6x^2 - 8x - 2x^2 + 18x + 24$	M1dep	full expansion with correct multiplication of their 3 or 4 terms by x and -3
	$2x^3 - 12x^2 + 10x + 24$	A1	
	Additional Guidance		
	Do not ignore further incorrect simplification or attempt to solve after correct answer seen		

Q	Answer	Mark	Comments
26	Alternative method 1		
	7.2 ÷ 5 or 1.44	M1	
	$\sqrt{\text{their } 1.44}$ or 1.2	M1dep	
	1 : 1.2	A1	
	Alternative method 2		
	$\sqrt{5} : \sqrt{7.2}$	M1	
	1 : $\frac{\sqrt{\text{their } 7.2}}{\sqrt{\text{their } 5}}$	M1dep	
	1 : 1.2	A1	
	Alternative method 3		
	$\sqrt{25} : \sqrt{36}$	M1	
	5 : 6	M1dep	
	1 : 1.2	A1	
	Additional Guidance		
	1 : 1.2 on answer line with no evidence of incorrect method		M1M1A1

Q	Answer	Mark	Comments
27(a)	Alternative method 1: $DH + HX$		
	$HE = a - b$	M1	implied by $HX = \frac{2}{5}a - \frac{2}{5}b$
	$(b + \frac{2}{5}(a - b) =) b + \frac{2}{5}a - \frac{2}{5}b$ $\frac{2}{5}a + \frac{3}{5}b$	A1	
	Alternative method 2: $DE + EX$		
	$EH = b - a$	M1	implied by $EX = \frac{3}{5}b - \frac{3}{5}a$
	$(a + \frac{3}{5}(b - a) =) a + \frac{3}{5}b - \frac{3}{5}a$ $= \frac{2}{5}a + \frac{3}{5}b$	A1	

Q	Answer	Mark	Comments
27(b)	Alternative method 1: DF from $DE + EF = DE + \frac{1}{5} EG$		
	$(EG =) -a + 6b$ or $(EF =) -\frac{1}{5}a + \frac{6}{5}b$	M1	oe
	$(EF =) -\frac{1}{5}a + \frac{6}{5}b$ and $(DF =) a - \frac{1}{5}a + \frac{6}{5}b$	M1	oe
	$(DF =) \frac{4}{5}a + \frac{6}{5}b$	A1	
	$(DF =) 2(\frac{2}{5}a + \frac{3}{5}b)$ and Yes	A1	oe using a different correct scalar multiple for DF and DX

Mark scheme for Question 27(b) continues on next page

Q	Answer	Mark	Comments
27(b) cont	Alternative method 2: DF from $DG + GF = DG + \frac{4}{5} GE$		
	$(GE =) -6b + a$ or $(GF =) -\frac{24}{5}b + \frac{4}{5}a$	M1	oe
	$(GF =) -\frac{24}{5}b + \frac{4}{5}a$ and $(DF =) 6b - \frac{24}{5}b + \frac{4}{5}a$	M1	oe
	$(DF =) \frac{4}{5}a + \frac{6}{5}b$	A1	
	$(DF =) 2(\frac{2}{5}a + \frac{3}{5}b)$ and Yes	A1	oe using a different correct scalar multiple for DF and DX

Mark scheme for Question 27(b) continues on next page

Q	Answer	Mark	Comments
27(b) cont	Alternative method 3: XF from $XE + EF = \frac{3}{5} HE + \frac{1}{5} EG$		
	$(XE =) \frac{3}{5} a - \frac{3}{5} b$ or $(EF =) -\frac{1}{5} a + \frac{6}{5} b$	M1	oe
	$(XF =) \frac{3}{5} a - \frac{3}{5} b - \frac{1}{5} a + \frac{6}{5} b$	M1	oe
	$(XF =) \frac{2}{5} a + \frac{3}{5} b$	A1	
	$(XF =) 1 \times (\frac{2}{5} a + \frac{3}{5} b)$ and Yes	A1	oe using a different correct scalar multiple for XF and DX

Mark scheme for Question 27(b) continues on next page

Q	Answer	Mark	Comments
27(b) cont	Alternative method 4: XF from $XH + HG + GF = \frac{1}{5}EH + HG + \frac{4}{5}GE$		
	$(XH =) = -\frac{2}{5}a + \frac{2}{5}b$ or $(GF =) = -\frac{24}{5}b + \frac{4}{5}a$	M1	oe
	$(XF =) = -\frac{2}{5}a + \frac{2}{5}b + 5b - \frac{24}{5}b + \frac{4}{5}a$	M1	oe
	$(XF =) = \frac{2}{5}a + \frac{3}{5}b$	A1	
	$(XF =) = 1 \times (\frac{2}{5}a + \frac{3}{5}b)$ and Yes	A1	oe using a different correct scalar multiple for XF and DX
	Additional Guidance		
	Method marks may be awarded for correct work seen on diagram or in working, with no or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments	
28	5.825 or 5.835 or 115.5 or 116.5	B1	accept 5.8249̇ or 5.8249... accept 116.49̇ or 116.49...	
	their 5.825 ÷ their 116.5	M1	their 5.825 must be (5.82, 5.825] their 116.5 must be [116.5, 117)	
	0.05 and correct working	A1	oe eg $\frac{5}{100}$	
	Additional Guidance			
	Answer 0.05 with no correct working			B0M0A0
	5.8249 exact value with no continuation dots seen			B0

Q	Answer	Mark	Comments
29	Alternative method 1		
	<i>OB</i> and <i>OC</i> are right angles and <i>BOC</i> (obtuse) = $180 - x$	M1	may be on diagram
	$BAC = 90 - \frac{x}{2}$	M1dep	oe may be on diagram
	<p><i>BOC</i> (reflex) = $180 + x$ and $ABO + ACO = 360 - (90 - \frac{x}{2} + 180 + x)$ or $90 - \frac{x}{2}$ and $ABO = \frac{1}{2}(90 - \frac{x}{2})$ $= 45 - \frac{x}{4}$ with M2 scored</p>	A1	oe $360 - 90 + \frac{x}{2} - 180 - x$
	<p>All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles around a point add to 360°</p>	A1	

Mark scheme for Question 29 continues on next page

Q	Answer	Mark	Comments
29 cont	Alternative method 2		
	<i>OBD</i> and <i>OCD</i> are right angles and <i>BOC</i> (obtuse) = $180 - x$	M1	may be on diagram
	$BAC = 90 - \frac{x}{2}$	M1dep	oe may be on diagram
	BOC (reflex) = $180 + x$ and $BAD = \frac{1}{2}(90 - \frac{x}{2})$ or $45 - \frac{x}{4}$ and $ABO = 180 - (45 - \frac{x}{4}) - (90 + \frac{x}{2})$ $= 45 - \frac{x}{4}$ with M2 scored	A1	
	All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles in a triangle add up to 180°	A1	

Mark scheme for Question 29 continues on next page

Q	Answer	Mark	Comments
29 cont	Alternative method 3		
	<i>OBD</i> and <i>OCD</i> are right angles and <i>BOC</i> (obtuse) = $180 - x$	M1	may be on diagram
	$BAC = 90 - \frac{x}{2}$	M1dep	oe may be on diagram
	$ABC = \frac{1}{2}[180 - (90 - \frac{x}{2})]$ $= 45 + \frac{x}{4}$ and $OBC = \frac{1}{2}[180 - (180 - x)]$ $= \frac{x}{2}$ and $ABO = 45 + \frac{x}{4} - \frac{x}{2}$ $= 45 - \frac{x}{4}$ with M2 scored	A1	
	All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles in a triangle add up to 180° (base angles in an) isosceles triangle (are equal)	A1	

Mark scheme for Question 29 continues on next page

Q	Answer	Mark	Comments
29 cont	Alternative method 4		
	OBD is a right angle and $BDO = \frac{x}{2}$	M1	may be on diagram
	$BOD = 90 - \frac{x}{2}$	M1dep	may be on diagram
	$OAB + ABO = 90 - \frac{x}{2}$ and $ABO = 45 - \frac{x}{4}$ with M2 scored	A1	
	All reasons given tangent meets the radius at 90° the diagram is symmetrical or angles in a triangle add up to 180° exterior angle of a triangle is equal to the sum of the opposite interior angles OA and OB are radii, so triangle ABO is isosceles (base angles in an) isosceles triangle (are equal)	A1	
	Additional Guidance		
	Using a value for x	M0M0A0A0	

Q	Answer	Mark	Comments
30(a)	$(r_2 =) 5.31(0\dots)$	B1	
	$(r_3 =) 5.15(2\dots)$ or $5.2(0)$	B1ft	ft their $5.15(2\dots)$ to 2 dp or better
	Additional Guidance		
	eg $r_2 = 5.15(2\dots)$ and $r_3 = 5.23(1\dots)$		

Q	Answer	Mark	Comments
30(b)	5.2	B1	
	Additional Guidance		
	5.20		B0