

OXFORD

INTERNATIONAL
AQA EXAMINATIONS

INTERNATIONAL GCSE MATHEMATICS EXTENSION 9260/1E

Paper 1E

Mark scheme

June 2023

Version: 1.0 Final



2 3 6 Y 9 2 6 0 / 1 E / M S

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.

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Key to mark types and abbreviations

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.

Q	Answer	Mark	Comments
1	500%	B1	

Q	Answer	Mark	Comments
2	$2n - \frac{3}{2}$	B1	

Q	Answer	Mark	Comments
3	624	B1	

Q	Answer	Mark	Comments
4	$\frac{4x+3y}{12}$	B1	

Q	Answer	Mark	Comments
5	$\frac{2}{11+5+2} \times 360$ or 100 or 220	M1	oe eg $360 \div 9$ or 2×20
	40	A1	
	Additional Guidance		
	Embedded answer		M1A0

Q	Answer	Mark	Comments
6(a)	At least 3 points correctly plotted	M1	$\pm \frac{1}{2}$ square (5, 156), (6, 170), (7, 176), (8, 180)
	All 4 points correctly plotted and joined with straight lines	A1	$\pm \frac{1}{2}$ square
	Additional Guidance		
	$\pm \frac{1}{2}$ square for plotting means half a small square horizontally and vertically		
	If a point is within tolerance the line must be within $\pm \frac{1}{2}$ square horizontally or vertically of their point		
	Ignore trend lines that may be working for part (b)		
	Ignore points and lines after Week 8		
	Mark intention for unruled lines		

Q	Answer	Mark	Comments
6(b)	[182, 190]	B1	
	Additional Guidance		
	Answer in range with or without working, with no graph or incorrect graph		B1
	If a range is given on answer line accept if both values are in range eg 184 - 188		B1

Q	Answer	Mark	Comments	
7	$x^3 - 4x^2$ $x^2 + 3x - 4$ $x^2 - 4$ $x^2 - 4x$ $x(x - 4)$ $(x - 4)(x + 1)$ $(x - 1)(x + 4)$ $(x - 2)(x + 2)$ $x^2(x - 4)$	B3	B1 each correct match	
	Additional Guidance			
	Two lines from one expression on the left is choice			

Q	Answer	Mark	Comments
8(a)	120 000	B1	oe correct value in the form $a \times 10^b$ eg 12×10^4
	1.2×10^5	B1ft	ft the answer to their calculation converted to standard form
	Additional Guidance		
	1.2×10^5		B1B1
	1.2×10^5 in working but answer 120 000		B1B0
	$\frac{6}{5} \times 10^5$		B1B0

Q	Answer	Mark	Comments
8(b)	smallest 6.2×10^{-5} 3.9×10^{-4} largest 8.5×10^{-4} with no incorrect conversions seen	B2	B1 6.2×10^{-5} the smallest with no incorrect conversion of it seen or 0.000 062 or 0.000 39 or 0.000 85
	Additional Guidance		
	If only two of the answer lines are completed using different numbers, the number on the third answer line is implied		
	Standard form numbers may be written in any equivalent form on answer lines		
	Correct conversion to a fraction does not gain B1 but an incorrect fraction will count as an incorrect conversion		
	smallest 6.2×10^{-5} 8.5×10^{-4} largest 3.9×10^{-4}		B1

Q	Answer	Mark	Comments
9	$\frac{1}{2} \times 3 \times 4$ or 6	M1	oe may be on diagram
	30	A1	SC1 67 or 60
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments
10(a)	$3x + x + 17 + 23 = 100$ or $4x + 40 = 100$	M1	oe
	$(x =) 15$ or $(3x =) 45$	A1	oe may be seen on diagram
	$3 \times \text{their } 15 + 17$ or 62	M1	may be seen on diagram implied by $\frac{62}{100}$ oe fraction or 62% their 15 may be any value
	0.62	A1ft	ft $\frac{3 \times \text{their } 15 + 17}{100}$ written as a decimal if their 15 is a positive integer ≤ 27 SC3 0.45 accept 0.6 if 0.62 or 62 seen
	Additional Guidance		
	Ignore any attempt to convert the correct decimal answer to a fraction or percentage		
	T & I to find $x = 15$		M1A1
	T & I with $x \neq 15$		M0A0

Q	Answer	Mark	Comments
10(b)	$(P \cup Q)'$	B1	

Q	Answer	Mark	Comments
11(a)	$2^3 \times 3 \times 5$ or 120	B1	oe
	Additional Guidance		
	Ignore incorrect evaluation once $2^3 \times 3 \times 5$ seen but do not accept 1200 or 123480		

Q	Answer	Mark	Comments
11(b)	$2^4 \times 3^2 \times 5^2 \times 7^3$ or 1234800	B1	oe
	Additional Guidance		
	Ignore incorrect evaluation once $2^4 \times 3^2 \times 5^2 \times 7^3$ seen but do not accept 1200 or 123480		

Q	Answer	Mark	Comments
12	Alternative method 1 Cost of twelve roses		
	$25.5(0) \times 2$ or 51(.00)	M1	oe shop A
	5.25×0.2 or 1.05 or $1 - 0.2$ or 0.8	M1	oe may be embedded shop B implied by 4.2(0) or 50.4(0) or 12.6(0)
	$(5.25 - \text{their } 1.05) \times 12$ or $5.25 \times \text{their } 0.8 \times 12$ or $4.2(0) \times 12$ or 50.4(0)	M1dep	oe shop B dep on 2nd M1
	$5.7(0) \times 1.5 \times 6$ or 51.3(0)	M1	oe eg $(5.7(0) + 2.85) \times 6$ shop C
	Shop B and Total cost \$50.4(0) and 51(.00) and 51.3(0)	A1	
	Alternative method 2 Cost per rose		
	$25.5(0) \div 6$ or 4.25	M1	oe shop A
	5.25×0.2 or 1.05 or $1 - 0.2$ or 0.8	M1	oe may be embedded shop B implied by 4.2(0)
	$5.25 - \text{their } 1.05$ or $5.25 \times \text{their } 0.8$ or 4.2(0)	M1dep	oe shop B dep on 2nd M1
	$5.7(0) \times 1.5 \div 2$ or 4.27(5) or 4.28	M1	oe eg $(5.7(0) + 2.85) \div 2$ shop C
	Shop B and Total cost \$50.4(0) and 4.25 and 4.2(0) and 4.27(5) or 4.28	A1	

Alternative method 3 and Additional Guidance on the next page

12 cont	Alternative method 3 Cost of six roses																				
	5.25 × 0.2 or 1.05 or 1 – 0.2 or 0.8		M1	oe may be embedded shop B implied by 4.2(0) or 25.2(0) or 6.3(0)																	
	(5.25 – their 1.05) × 6 or 5.25 × their 0.8 × 6 or 4.2(0) × 6 or 25.2(0)		M1dep	oe shop B																	
	their 25.2(0) × 2 or 50.4(0)		M1dep	oe shop B their 25.2(0) must have been seen																	
	5.7(0) × 1.5 × 3 or 25.65		M1	oe eg (5.7(0) + 2.85) × 3 shop C																	
	Shop B and Total cost \$50.4(0) (and 25.5(0)) and 25.2(0) and 25.65		A1																		
	Additional Guidance																				
	Use the scheme which favours the student																				
	<table><tr><td>Shop</td><td>Cost of 1</td><td>Cost of 2</td><td>Cost of 6</td></tr><tr><td>A</td><td>4.25</td><td>8.5(0)</td><td>25.5(0)</td></tr><tr><td>B</td><td>4.2(0)</td><td>8.4(0)</td><td>25.2(0)</td></tr><tr><td>C</td><td>4.27(5) or 4.28</td><td>8.55</td><td>25.65</td></tr></table>				Shop	Cost of 1	Cost of 2	Cost of 6	A	4.25	8.5(0)	25.5(0)	B	4.2(0)	8.4(0)	25.2(0)	C	4.27(5) or 4.28	8.55	25.65	
	Shop	Cost of 1	Cost of 2	Cost of 6																	
	A	4.25	8.5(0)	25.5(0)																	
	B	4.2(0)	8.4(0)	25.2(0)																	
C	4.27(5) or 4.28	8.55	25.65																		
Follow Alt 1 if comparing the cost of 3 or 4 roses																					
For the second mark of Alts 1 and 2 and the first mark of Alt 3, 5.25 × 0.2 may be seen embedded eg 12 × 5.25 × 0.2				M1																	
Do not allow × 20% for × 0.2 unless evaluated correctly																					

Q	Answer	Mark	Comments
13	Enlargement	B1	oe eg enlarge(d) or enlarging
	$(\times) \frac{1}{3}$	B1	scale factor allow 0.33(...) for $\frac{1}{3}$
	(1, 1)	B1	centre
	Additional Guidance		
	Do not accept terms like reduction, makes smaller, makes bigger or negative enlargement for the first B mark		
	Combined transformation eg enlargement then down 4		1st B0
	Do not accept $\div 3$ for the scale factor		

Q	Answer	Mark	Comments
14(a)	One pair of intersecting arcs with equal radii ± 2 mm, centres <i>A</i> and <i>B</i>	M1	
	Two pairs of intersecting arcs with equal radii ± 2 mm, centres <i>A</i> and <i>B</i> and perpendicular bisector drawn	A1	
	Additional Guidance		
	Two arcs touching but not intersecting		MOA0
	Allow dashed line for perpendicular bisector		
	Ignore extra arcs even if incorrect		

Q	Answer	Mark	Comments
14(b)	Circle, centre C, radius [5.8, 6.2] cm or circle, centre C, radius [3.8, 4.2] cm	M1	
	Circle, centre C, radius [5.8, 6.2] cm and circle, centre C, radius [3.8, 4.2] cm and region indicated	A1	allow any unambiguous indication eg labelled R or shaded
	Additional Guidance		
	Must use compasses		

Q	Answer	Mark	Comments
15	2.5	B1	

Q	Answer	Mark	Comments
16	Alternative method 1		
	$x^2 + x^2 = 10^2$ or $2x^2 = 100$ or $x^2 = 50$	M1	oe eg $x^2 = 5^2 + 5^2$ any letter
	$\sqrt{\text{their } 50}$ or [7, 7.1] or $10 + 2\sqrt{50}$ or $10 + 10\sqrt{2}$	M1dep	oe may be seen on diagram
	24.1(4...) or 24.2	A1	
	Alternative method 2		
	$x = 10 \sin 45$ or $x = 10 \cos 45$	M1	oe any letter
	$5\sqrt{2}$ or [7, 7.1] or $10 + 2\sqrt{50}$ or $10 + 10\sqrt{2}$	M1dep	oe may be seen on diagram
	24.1(4...) or 24.2	A1	
	Additional Guidance		
	PQ or PR correct	M1M1	

Q	Answer	Mark	Comments
17(a)	0.6 (Match 2 top Win) and 0.7 (Match 2 bottom Lose)	B2	oe B1 0.6 or 0.7 in correct position

Q	Answer	Mark	Comments
17(b)	Alternative method 1		
	0.8 × 0.4 or 0.32 or 0.2 × 0.3 or 0.06	M1	oe
	0.8 × 0.4 + 0.2 × 0.3 or 0.32 + 0.06	M1dep	oe
	0.38	A1	oe
	Alternative method 2		
	0.8 × their 0.6 or 0.48 or 0.2 × their 0.7 or 0.14	M1	oe ft their tree diagram with probabilities between 0 and 1
	1 – 0.8 × their 0.6 – 0.2 × their 0.7 or 1 – 0.48 – 0.14	M1dep	oe ft their tree diagram with probabilities between 0 and 1
	0.38	A1ft	oe ft their tree diagram with probabilities between 0 and 1
	Additional Guidance		
	One correct product seen next to tree or in working		M1
	Ignore simplification or conversion if correct answer seen		

Q	Answer	Mark	Comments
18(a)	$\begin{pmatrix} 2 & 11 \\ -6 & 3 \end{pmatrix}$	B2	B1 two correct elements in their correct positions SC1 2, 11, -6 and 3 with no other numbers
	Additional Guidance		
	Ignore commas or fraction lines in the matrix		
	Correct matrix with further simplification		B1
	B1 response followed by further simplification		B1

Q	Answer	Mark	Comments
18(b)	$4 - 2c = 20$ or $8d - 18 = 2d$ or $4 - 2c$ and $8d - 18$	M1	oe equations or expressions
	$c = -8$	A1	
	$d = 3$	A1	
	Additional Guidance		
	c and d may be worked out in either order and may be seen in working lines		
	One correct value implies 2 marks unless from incorrect method		
	$\begin{pmatrix} 4 - 2c \\ 8d - 18 \end{pmatrix} = \begin{pmatrix} 20 \\ 2d \end{pmatrix}$		M1

Q	Answer	Mark	Comments
19	$\frac{a+4}{2}$	B1	

Q	Answer	Mark	Comments
20	$\frac{1}{262\,144}$	B1	

Q	Answer	Mark	Comments
21(a)	37	B1	

Q	Answer	Mark	Comments
21(b)	Points plotted with upper class boundaries	B1	5, 10, 15, 20, 25 $\pm \frac{1}{2}$ square must be increasing
	Points at correct cf values and smooth curve or polygon	B1	7, 19, 42, 56, 60 $\pm \frac{1}{2}$ square
	Additional Guidance		
	$\pm \frac{1}{2}$ square for plotting means half a small square horizontally and vertically		
	If a point is within tolerance the line must be within $\pm \frac{1}{2}$ square horizontally or vertically of their point		
	A correct graph should start at (0, 0) or (5, 7) The graph should end at cf = 60 unless continued by a horizontal line With any other starting point or end point, but otherwise points plotted correctly		B1B0
	Points plotted at lower class boundaries or midpoints, but with correct cf values and smooth curve or polygon for their points		B0B1
	Bars drawn with correct curve		B1B1
	Bars drawn without correct curve		B0B0

Q	Answer	Mark	Comments
22	$8\mathbf{a}$ or $-8\mathbf{a}$ or $2\mathbf{a}$ or $-2\mathbf{a}$ or $6\mathbf{a}$ or $-6\mathbf{a}$	M1	may be seen on diagram implied eg by $\overrightarrow{PS} = -7\mathbf{a} + 2\mathbf{b}$
	$\overrightarrow{ST} = \frac{1}{4} \times 8\mathbf{a}$ or $\overrightarrow{ST} = 2\mathbf{a}$ or $\overrightarrow{TS} = \frac{1}{4} \times -8\mathbf{a}$ or $\overrightarrow{TS} = -2\mathbf{a}$ or $\overrightarrow{TR} = \frac{3}{4} \times 8\mathbf{a}$ or $\overrightarrow{TR} = 6\mathbf{a}$ or $\overrightarrow{RT} = \frac{3}{4} \times -8\mathbf{a}$ or $\overrightarrow{RT} = -6\mathbf{a}$	M1dep	oe may be seen on diagram but must have direction indicated labels may be implied
	$\mathbf{a} + 2\mathbf{b} - \frac{3}{4} \times 8\mathbf{a}$ or $\mathbf{a} + 2\mathbf{b} - 6\mathbf{a}$	M1dep	oe eg $\mathbf{a} + 2\mathbf{b} - 8\mathbf{a} + \frac{1}{4} \times 8\mathbf{a}$ or $-7\mathbf{a} + 2\mathbf{b} + 2\mathbf{a}$
	$2\mathbf{b} - 5\mathbf{a}$ or $-5\mathbf{a} + 2\mathbf{b}$	A1	

Q	Answer	Mark	Comments
23	Alternative method 1 Using total surface area of X and Y		
	$150 \div 6$ or 25	M1	implied by cube edge of 5
	$2 \times$ their 25 or 50	M1dep	surface area of two extra faces
	150 + their 50 or 200 or $150 - 120 +$ their 50 or $30 +$ their 50	M1dep	oe total surface area of X and Y or surface area of Y
	80	A1	
	Alternative method 2 Subtracting surface area of cut face		
	$150 \div 6$ or 25	M1	implied by cube edge of 5
	$120 -$ their 25 or 95	M1dep	surface area of X – area of cut face
	$150 -$ their 95 or 55	M1dep	surface area of Y – area of cut face
	80	A1	
	Alternative method 3 Working out width of X or Y		
	$150 \div 6$ or 25	M1	implied by cube edge of 5
	$2 \times$ their 25 or 50	M1dep	may be implied
	$\frac{120 - \text{their } 50}{4 \times \sqrt{\text{their } 25}}$ or 3.5 or $5 - \frac{120 - \text{their } 50}{4 \times \sqrt{\text{their } 25}}$ or 1.5	M1dep	oe sets up and solves equation eg $5x \times 4 + 2 \times 25 = 120$ or $5(5 - y) \times 4 + 2 \times 25 = 120$ to find width of X or Y
	80	A1	
	Alternative method 4 Working out area of rectangular face of X or Y		
	$150 \div 6$ or 25	M1	
	$2 \times$ their 25 or 50	M1dep	may be implied
	$\frac{120 - \text{their } 50}{4}$ or 17.5 or their 25 – $\frac{120 - \text{their } 50}{4}$ or 7.5	M1dep	oe sets up and solves equation eg $x \times 4 + 2 \times 25 = 120$ or $(25 - y) \times 4 + 2 \times 25 = 120$ to find rectangular face of X or Y
	80	A1	

Additional Guidance on the next page

23 cont	Additional Guidance	
	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	$4 \times 1.5 \times 5 + 2 \times 25$ or $4 \times 7.5 + 2 \times 25$ oe	M1M1M1

Q	Answer	Mark	Comments
24(a)	$\frac{2}{5x}$	B1	oe eg $\frac{2}{5}x^{-1}$ or $\frac{0.4}{x}$
	Additional Guidance		
	$f(5x) = \frac{2}{5x}$		B1
	Condone $y = \frac{2}{5x}$ or $f\left(\frac{2}{5x}\right)$ or $f(x) = \frac{2}{5x}$		B1
	$\frac{2}{5x}$ followed by answer $\frac{2}{5}x$		B0
	Ignore any attempt to simplify, substitute or solve		
	Ignore any reference to a domain		

Q	Answer	Mark	Comments
24(b)	$(x+5)^2$ or $(-4)(x+5)$	M1	oe
	$x^2 + 5x + 5x + 25 - 4x - 20 + 7$ or $(x+5)^2 - 4(x+5) + 7$ expanded with one sign error or one omission or one arithmetic error	M1dep	oe
	$x^2 + 6x + 12$	A1	accept $b = 6, c = 12$
	Additional Guidance		
	$x^2 + 5x + 5x + 25 - 4x + 20 + 7$		M1M1A0
	$(x+5)^2 = x^2 + 25$ is two omissions		M1M0A0

Q	Answer	Mark	Comments
25	$\frac{10}{4-\sqrt{11}} \times \frac{4+\sqrt{11}}{4+\sqrt{11}}$	M1	oe
	$\frac{40+10\sqrt{11}}{16+4\sqrt{11}-4\sqrt{11}-11}$ or $\frac{40+10\sqrt{11}}{16-11}$ or $\frac{40+10\sqrt{11}}{5}$	M1dep	with $4+\sqrt{11}$ seen oe with numerator written as $10(4+\sqrt{11})$ eg $\frac{10(4+\sqrt{11})}{16+4\sqrt{11}-4\sqrt{11}-11}$
	$8+2\sqrt{11}$ with working for M2 seen	A1	accept $p=8, q=2$ with M2 seen
	Additional Guidance		
	$2(4+\sqrt{11})$ with working for M2 seen		M1M1A0
	$2(4+\sqrt{11})$ with no working		M0M0A0
	$8+2\sqrt{11}$ with no working		M0M0A0

Q	Answer	Mark	Comments
26	Alternative method 1		
	$5n^2(n^2 + 2)$	M1	
	M1 seen and $5n^2 - n^2$	M1dep	
	M2 seen and $4n^2$ and valid explanation	A1	valid explanation eg $4n^2 = (2n)^2$ or $\sqrt{4n^2} = 2n$
	Alternative method 2 Using a common denominator		
	$5n^4 + 10n^2 - n^4 - 2n^2$ or $4n^4 + 8n^2$	M1	
	M1 seen and $\frac{4n^2(n^2 + 2)}{n^2 + 2}$	M1dep	
	M2 seen and $4n^2$ and valid explanation	A1	valid explanation eg $4n^2 = (2n)^2$ or $\sqrt{4n^2} = 2n$
	Additional Guidance		
	M2 seen and $4n^2$ and 4 is a square number, n^2 is a square number	M1M1A1	
	M2 seen and $4n^2$ is a square number	M1M1A0	
	$\frac{5n^4 + 10n^2}{n^2 + 2} = 5n^2$ with no working	M0M0A0	
	$\frac{5n^4 + 10n^2}{n^2 + 2} = 5n^2$ from incorrect working eg $\frac{5n^4 + 10n^2}{n^2 + 2} = \frac{5n^4}{n^2} + \frac{10n^2}{2} = 5n^2$	M0M0A0	

Q	Answer	Mark	Comments
27	$\cos w = \frac{16^2 + 14^2 - 11^2}{2 \times 16 \times 14}$ or $11^2 = 16^2 + 14^2 - 2 \times 16 \times 14 \cos w$	M1	oe any letter
	$\cos^{-1} \frac{16^2 + 14^2 - 11^2}{2 \times 16 \times 14}$ or $\cos^{-1} \frac{331}{448}$ or $\cos^{-1} 0.738(\dots)$ or $\cos^{-1} 0.739$ or $\cos^{-1} 0.74$	M1dep	oe
	[42.26, 42.44]	A1	accept 42 with correct working

Q	Answer	Mark	Comments
28	$25 = a^2$	M1	
	$a = \sqrt{25}$ or $a = 5$ or 5^{-1}	M1dep	oe eg $\frac{1}{5}$ or $\left(-1, \frac{1}{5}\right)$
	0.2	A1	accept $(-1, 0.2)$
	Additional Guidance		
	Ignore any attempt to convert the correct decimal answer to a fraction		

Q	Answer	Mark	Comments
29(a)	$y \geq 0$ $x \geq 1$ $x + y < 8$	B3	oe B2 two correct or $y > 0$ and $x > 1$ and $x + y \leq 8$ oe B1 one correct or $x + y = 8$ or $x + y \leq 8$ or $x + y \geq 8$ or $x + y > 8$ or $x + y \neq 8$ oe
	Additional Guidance		
	Allow any equivalent eg $x + y < 8$ may be seen as $y < 8 - x$ or $x < 8 - y$		
	Mark each answer line independently, even if the inequalities contradict		
	Allow an upper bound for y eg $0 \leq y < 7$ (bound no lower than 7)		
	Allow an upper bound for x eg $1 \leq x < 8$ (bound no lower than 8)		
	Allow a lower bound for $x + y$ eg $0 \leq x + y < 8$ (bound no higher than 0)		

Q	Answer	Mark	Comments
29(b)	(1, 2)	B2	B1 $y = x$ drawn on the diagram, dotted or solid SC1 (1, 0) or (1, y) where $1 \leq y < 2$
	Additional Guidance		
	(1, 2) with incorrect or no line added to diagram		B2

Q	Answer	Mark	Comments
30	6250 or 6150 or 117.5 or 118.5	B1	oe eg 1 min 57.5 s
	$\frac{\text{their max length}}{\text{their min time}}$ or $\frac{\text{their max length}}{54}$ or $54 \times \text{their min time}$	M1	$6200 < \text{their max length} \leq 6300$ or $6.2 < \text{their max length} \leq 6.3$ $117 \leq \text{their min time} < 118$
	$\frac{6250}{117.5}$ and [53, 53.2] and Yes or $\frac{6250}{54}$ and 115(.7...) and 117.5 and Yes or 54×117.5 and 6345 and 6250 and Yes	A1	oe
	Additional Guidance		
	Allow values in km for B1 and M1 but must convert to m/s for A1		
	$\frac{6300}{117}$		B0M1A0

Q	Answer	Mark	Comments
31(a)	180	B1	may be on diagram

Q	Answer	Mark	Comments
31(b)	$(270^\circ, 0)$	B1	may be on diagram condone degrees symbol missing

Q	Answer	Mark	Comments
31(c)	120 or 240 or 540 – 60	M1	may be on diagram
	480 with no other answers	A1	
	Additional Guidance		
	M1 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments	
32	$d = 3, e = 2, f = -1$	B4	B3 $d = 3$ and $e = 2$ B2 $e = 2$ and $f = -1$ B1 $e = 2$ or $f = -1$ or $dx^2 - 2dex + de^2 + f$ or $dx^2 - 2dex + 11$ or $d(x^2 - 2ex + e^2) + f$ or $-1 = 4d - 4de + de^2 + f$ or $-1 = 4d - 4de + 11$	
	Additional Guidance			
	$3(x - 2)^2 - 1$ with no contradiction on answer line		B4	
	$3(x - 2)^2 + f$ with no contradiction on answer line		B3	
	$d(x - 2)^2 - 1$ with no contradiction on answer line		B2	
	$(\dots\dots)^2 - 1$ or $(x - 2)^2$ with no contradiction on answer line		B1	
	$3x^2 - 12x + 11$ with no other creditworthy work		B0	

Q	Answer	Mark	Comments
33	Alternative method 1 Working with powers of 2		
	$\left(8^{\frac{2}{3}} = \right) 2^2$	M1	
	$\left(8^{\frac{2}{3}} \times 2^{-a} = \right) 2^{2-a}$	M1dep	
	$(4^x =) 2^{2x}$	M1	
	$(x =) 1 - \frac{a}{2}$	A1	oe

Alternative methods 2 and 3 and Additional Guidance on the next page

33 cont	Alternative method 2 Working with powers of 4		
	$\left(8^{\frac{2}{3}} = \right) 4$	M1	
	$(2^{-a} =) 4^{-\frac{a}{2}}$	M1	
	$\left(8^{\frac{2}{3}} \times 2^{-a} = \right) 4^{1-\frac{a}{2}}$	M1dep	dep on M2
	$(x =) 1 - \frac{a}{2}$	A1	oe
	Alternative method 3		
	$\left(8^{\frac{2}{3}} = \right) 4$	M1	
	$(4^x \div 4 =) 4^{x-1}$	M1dep	
	$(4^{x-1} =) 2^{2(x-1)}$	M1dep	
	$(x =) 1 - \frac{a}{2}$	A1	oe
	Additional Guidance		
	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		
	Ignore further incorrect simplification once correct expression seen		
	$2 - a = 2x$ (not from incorrect work)		M1M1M1
	$2^2 \times 2^{-a} = 2^{2x}$		M1M0M1
	$(2^2)^x$ needs the brackets removing for third M in Alt 1		