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Mark scheme

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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	1180	B1	

Q	Answer	Mark	Comments
2	250%	B1	

Q	Answer	Mark	Comments
3	$x = y^2 - 5$	B1	

Q	Answer	Mark	Comments
4	(1.25, 0.8)	B1	

Q	Answer	Mark	Comments
5	$\sin (180 - 125) = \frac{x}{16}$ or $\sin 55 = \frac{x}{16}$	M1	any letter or <i>CD</i> for x oe eg $\cos (125 - 90) = \frac{x}{16}$ or $\cos 35 = \frac{x}{16}$
	$16 \times \sin 55$	M1dep	oe eg $16 \times \cos 35$
	[13.1, 13.12]	A1	allow 13 with at least M1 or an answer in the range [13.1, 13.12] seen
	Additional Guidance		
	If $\cos 55$ or $\sin 35$ and Pythagoras' Theorem or further trigonometry are used it must be a fully correct method that would lead to the correct value of x to score M2 eg $16 \times \cos 55 \times \tan 55$		M1M1
	$\sin 55 \times 16$		M1M1
	If the sine rule is used it must be manipulated to an equivalent form for each of the M marks, but may contain $\sin 90$ eg1 $x (\times) \sin 90 = 16 (\times) \sin 55$ eg2 $\sin 55 = \frac{x}{16} \times \sin 90$		M1M1 M1
	$\sin = \frac{x}{16}$ or $\sin \theta = \frac{x}{16}$ (unless recovered)		M0
	Answer from scale drawing		M0A0

Q	Answer	Mark	Comments
6(a)	$9n - 5$ or $-5 + 9n$	B2	oe eg $4 + 9(n - 1)$ B1 $9n (...)$
	Additional Guidance		
	Condone $T_n = 9n - 5$ or $n = 9n - 5$		B2
	Allow other letters eg $9x - 5$		B2
	Condone $n9 - 5$		B2
	Do not ignore further working for B2 eg $9n - 5 = 4n$		B1
	Ignore further working following a B1 answer eg $9n + 5 = 14n$		B1
	$4 + 9n$		B1
	$5 + 9(n - 1)$		B1
	$n9 (...)$		B1
	$9 + 5n$		B0
	$9n - 5n$		B0
	$n - 5$		B0

Q	Answer	Mark	Comments
6(b)	Yes and valid reason	B1	eg Yes, it is the 49th term Yes, it goes $\sqrt{48}$, $\sqrt{49}$, $\sqrt{50}$ oe Yes, $\sqrt{49} = 7$
	Additional Guidance		
	Ignore references to the sequence in part (a)		
	Ignore incorrect or irrelevant statements alongside a correct statement, unless contradictory eg Yes, $\sqrt{49} = 7$ It is the 7th term		B1
	Yes, $7^2 = 49$		B1
	Ticks No		B0
	Reference to $\sqrt{7}$		B0
	Yes, 7 is a square number		B0
	Yes, the 6th term is 49		B0

Q	Answer	Mark	Comments
7	Alternative method 1 – mixed number converted to an improper fraction		
	$\left(3\frac{3}{4}\right)\frac{15}{4}$	M1	oe improper fraction
	$\frac{2}{5} \times \frac{15}{4} = \frac{30}{20}$ or $\frac{2}{5} \times \frac{15}{4} = \frac{3}{2}$ with cancelling shown	A1	oe using equivalent fractions must show answer to multiplication of numerator and denominator or must show cancelling
	Alternative method 2 – both numbers converted to decimals		
	0.4 and 3.75	M1	
	$0.4 \times 3.75 = 1.5$	A1	
	Alternative method 3 – multiplication split		
	$\frac{2}{5} \times 3$ or $\frac{6}{5}$ or $1\frac{1}{5}$ or 1.2 and $\frac{2}{5} \times \frac{3}{4}$ or $\frac{6}{20}$ or $\frac{3}{10}$ or 0.3	M1	oe using equivalent fractions
	$1\frac{1}{5} + \frac{3}{10} = \frac{15}{10}$ and $\frac{15}{10} = \frac{3}{2}$ or $1\frac{1}{5} + \frac{3}{10} = 1\frac{5}{10}$ and $1\frac{5}{10} = 1\frac{1}{2}$ or $1.2 + 0.3 = 1.5$	A1	oe using equivalent fractions must show answer to addition with denominator 10 or equivalent common denominator
	Additional Guidance		
	Allow use of other denominators, eg both fractions changed to denominator 20		
	If decimals are used, 1.5 needs to be seen for the A mark		
	$\frac{2}{5} \times \frac{15}{4} = \frac{3}{2}$ without $\frac{30}{20}$ and no cancelling shown on multiplication		M1A0
	$\frac{2 \times 15}{5 \times 4}$		M1

Q	Answer	Mark	Comments	
8	$\frac{66}{120}$ or $\frac{33}{60}$ or $\frac{22}{40}$ or $\frac{11}{20}$ or 0.55 or 55%	B2	B1 $\frac{24+42}{50+70}$ oe or $\frac{24}{50}$ or $\frac{12}{25}$ or 0.48 or 48% or $\frac{42}{70}$ or $\frac{21}{35}$ or $\frac{3}{5}$ or 0.6 or 60% or $(1 -) \frac{26+28}{50+70}$ oe	
	Additional Guidance			
	Ignore incorrect cancelling or conversion to another form for B2 and B1 responses			
	B1 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts			
	B1 may be awarded for a correct fraction or decimal contained in an incorrect calculation, eg 0.48×0.52		B1	
	Any unprocessed fraction equivalent to $\frac{66}{120}$ eg $\frac{24+42}{120}$ or $\frac{66}{50+70}$		B1	
	0.45 or 45%	B1		

Q	Answer	Mark	Comments
9	False True Cannot tell	B3	B1 each correct answer
	Additional Guidance		
	Any indication		
	Two ticks in the same row is choice		
	A tick and a cross or a tick and two crosses in the same row – mark the ticks		

Q	Answer	Mark	Comments															
10	At least three correct pairs of coordinates	M1	seen or plotted $\pm \frac{1}{2}$ square may be seen in a table of values															
	At least four points plotted correctly	M1dep	$\pm \frac{1}{2}$ square															
	Fully correct smooth cubic curve	A1	$\pm \frac{1}{2}$ square															
	Additional Guidance																	
	For integer values of x																	
	<table><tr><td>x</td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td></tr><tr><td>y</td><td>-7</td><td>0</td><td>1</td><td>2</td><td>9</td></tr></table>					x	-2	-1	0	1	2	y	-7	0	1	2	9	
	x	-2	-1	0	1	2												
	y	-7	0	1	2	9												
	Decimal values for x are not needed, but if plotted must be correct and the curve must then pass through them ($\pm \frac{1}{2}$ square)																	
	<table><tr><td>x</td><td>-1.5</td><td>-0.5</td><td>0.5</td><td>1.5</td></tr><tr><td>y</td><td>-2.375</td><td>0.875</td><td>1.125</td><td>4.375</td></tr></table>					x	-1.5	-0.5	0.5	1.5	y	-2.375	0.875	1.125	4.375			
x	-1.5	-0.5	0.5	1.5														
y	-2.375	0.875	1.125	4.375														
Ignore any graph drawn beyond given domain																		
Curve must have a decreasing positive gradient to the left of (0, 1) and an increasing positive gradient to the right of (0, 1)																		
Condone a positive gradient at (0, 1)																		
Condone an infinite gradient at (-2, -7) and/or (2, 9)																		
If two points are plotted for a given x -value, then this is choice for that x -value unless their graph passes through one of the points																		

Q	Answer	Mark	Comments
11	0.1 or $\frac{1}{10}$ or 0.1^2 or 0.01 or $\frac{1}{100}$ or 80 000	M1	
	800 and 0.1 or $\frac{1}{10}$ or 0.1^2 or 0.01 or $\frac{1}{100}$ and 80 000	A1	
	Additional Guidance		
	0.01 oe from rounding 0.010609 does not score the M mark (but it may still be awarded for 80 000)		
	800 with no working		M0A0
	800 from rounding 839.(...) or 840		M0A0

Q	Answer	Mark	Comments
12	30	B2	B1 (sum of angles of polygon =) 540 or 720 or answer 210 or $(n - 2) \times 180 < 600$ oe
	Additional Guidance		
	720 – 510		B1
	510 – 360		B0

Q	Answer	Mark	Comments
13	1.9×3.5 or 6.65 or $\frac{1}{2} \times -0.4 \times 3.5^2$ or -2.45	M1	oe
	4.2 or $\frac{21}{5}$ or $4\frac{1}{5}$	A1	oe
	Additional Guidance		
	(1.9)(3.5)		M1
	$\frac{1}{2}(-0.4)(3.5)^2$		M1
	$\frac{1}{2} - 0.4 \times 3.5^2$ unless recovered with no other creditworthy working		M0
	$\frac{1}{2} \times -1.4^2$ with no other creditworthy working		M0

Q	Answer	Mark	Comments
14	Alternative method 1		
	even $\times$ odd = even or odd $\times$ even = even or even + even = even	M1	accept $8 \times \text{odd} = \text{even}$ accept $5 \times \text{even} = \text{even}$
	even $\times$ odd = even and odd $\times$ even = even and even + even = even	A1	accept $8 \times \text{odd} = \text{even}$ accept $5 \times \text{even} = \text{even}$
	Alternative method 2		
	$8(2n - 1) + 5(2m)$	M1	oe eg $2n + 1$ for $2n - 1$ m and n are interchangeable any letters
	$2(8n - 4 + 5m)$ or $16n - 8 + 10m$ and explanation as to why this is even eg each term can be divided by 2	A1	oe
	Additional Guidance		
	In alt 2 condone use of the same letter for M1 only eg $8(2n - 1) + 5(2n) (= 2(13n - 4))$		M1A0
	Numerical examples		M0
	even + even = even on its own		MOA0

Q	Answer	Mark	Comments
15	Rotation	B1	
	90° clockwise or 270° anticlockwise	B1	accept quarter turn clockwise or three-quarter turn anticlockwise
	(0, 1)	B1	
	Additional Guidance		
	Accept rotate or rotating for rotation		1st B1
	Do not accept turn or spin		1st B0
	Accept 90 clockwise		2nd B1
	Accept 270 anticlockwise		2nd B1
	Accept 0, 1 for (0, 1)		3rd B1
	Combined transformation eg rotate 90 and move 6 down		B0B0B0

Q	Answer	Mark	Comments
16	Alternative method 1		
	$98 \times 60 \times 0.125$ or 735 or 1.125	M1	oe eg $5880 \times \frac{12.5}{100}$
	$5880 + 98 \times 60 \times 0.125$ or $98 \times 60 \times 1.125$ or 6615	M1dep	oe
	$(98 + 2) \times (60 + x) = 6615$ or their $6615 \div (98 + 2)$ or their $6615 \div 100$ or 66.15	M1dep	oe any letter
	6.15	A1	
	Alternative method 2		
	1.125	M1	oe
	$1.125 \div \frac{98+2}{98}$ or $1.125 \div \frac{100}{98}$ or 1.1025	M1dep	oe
	$60 \times \text{their } 1.1025$ or 66.15	M1dep	oe
	6.15	A1	

Q	Answer	Mark	Comments
17	Alternative method 1		
	$x^2 + (2x)^2$ or $x^2 + 4x^2$ or $5x^2$	M1	
	$x^2 + 4x^2 = 8.05^2$ or $5x^2 = 8.05^2$ or $x^2 + 4x^2 = 64.8(\dots)$ or $5x^2 = 64.8(\dots)$ or $x^2 = 64.8(\dots) \div 5$ or $x^2 = 12.9(6\dots)$ or $x^2 = 13$	M1dep	oe
	3.6...	A1	oe SC2 4.6...
	Alternative method 2		
	$\tan BAC = 2$ or $(BAC =) \tan^{-1} 2$ or $63(.4\dots)$ or $\tan BCA = \frac{1}{2}$ or $(BCA =) \tan^{-1} \frac{1}{2}$ or $[26.56, 26.6]$	M1	
	$8.05 \times \cos (\text{their } 63(.4\dots))$ or $8.05 \times \sin (\text{their } [26.56, 26.6])$	M1dep	
	3.6...	A1	oe SC2 4.6...
	Additional Guidance		
	SC2 is from $x^2 + 2x^2 = 64.8(\dots)$ or $3x^2 = 64.8(\dots)$		
	$x^2 + (2x)^2 - 2 \times x \times 2x \times \cos 90$		M1

Q	Answer	Mark	Comments
18	$(2^{14} \times 2^{-5} =) 2^{14-5}$ or 2^9 or $(2^{14} \div 2^{-4} =) 2^{14-(-4)}$ or 2^{18} or $(2^{-5} \div 2^{-4} =) 2^{-5-(-4)}$ or 2^{-1} or $2^{14-5-(-4)}$ or $\frac{2^{14}}{2^{(1)}}$ or 8912 or $14 - 5 - (-4)$ or 13	M1	oe
	2^{13} or $k = 13$	A1	
	Additional Guidance		
	13 on answer line with 2^{13} or $k = 13$ in working		M1A1
	13 on answer line without 2^{13} or $k = 13$ in working		M1A0
	2^{14+4} or 2^{-5+4}		M1
	$\frac{4^9}{2^{-4}}$ followed by 2^{13}		M0A0

Q	Answer	Mark	Comments
19	40.5 cm	B1	

Q	Answer	Mark	Comments
20(a)	Points plotted with upper class boundaries and cf values	B1	$\pm \frac{1}{2}$ square
	Smooth curve or polygon starting at correct point for their points and going through all their points	B1ft	must be increasing and not a single straight line $\pm \frac{1}{2}$ square
	Additional Guidance		
	The correct graph should start at (0, 0) or (5, 2)		
	The correct graph should end at $t = 30$ or horizontal line to the right from (30, 40)		
	Histogram only		B0
	Histogram and graph		Mark graph

Q	Answer	Mark	Comments
20(b)	Alternative method 1 – using graph		
	Vertical line from 22 minutes to their graph	M1	$\pm \frac{1}{2}$ square ft their increasing graph implied by mark at correct place on the graph or on the vertical axis (but not on the horizontal axis) or by correct reading from their graph
	40 – the correct reading from their graph correctly evaluated	A1ft	$\pm \frac{1}{2}$ square ft their increasing graph must be a whole number
	Alternative method 2 – using table		
	$\frac{25-22}{25-20} \times (37-33)$ or $\frac{3}{5} \times 4$ or 2.4 or 2 or $\frac{22-20}{25-20} \times (37-33)$ or $\frac{2}{5} \times 4$ or 1.6 or 2	M1	oe implied by 5.4 or 34.6
	5	A1	
	Additional Guidance		
	Correct answer for their increasing graph, with or without evidence of using graph		M1A1

Q	Answer	Mark	Comments
20(c)	Alternative method 1 – using graph		
	Horizontal line from cf 10 to their graph or horizontal line from cf 30 to their graph	M1	$\pm \frac{1}{2}$ square ft their increasing graph implied by mark at correct place on the graph or on the horizontal axis (but not on the vertical axis) or by correct reading from their graph
	Correct upper quartile for their graph – correct lower quartile for their graph correctly evaluated	A1ft	ft their increasing graph
	Alternative method 2 – using table		
	$\frac{1}{19-9} \times (15-10) + 10$ or 10.5 or $15 + \frac{30-19}{33-19} \times (20-15)$ or $20 - \frac{3}{33-19} \times (20-15)$ or [18.9, 19]	M1	oe
	[8.4, 8.5]	A1	
	Additional Guidance		
	Correct interquartile range for their graph, with or without evidence of using graph	M1A1	

Q	Answer	Mark	Comments
21	$\begin{pmatrix} 17 \\ 8 \end{pmatrix}$	B1	

Q	Answer	Mark	Comments
22	27 and 36	B2	either order B1 two numbers greater than 10 with a HCF of 9 or a LCM of 108
	Additional Guidance		
	18 and 27		B1
	36 and 54		B1
	12 and 108		B1

Q	Answer	Mark	Comments
23	x^2 or $7x^5$ or $x^2(1 + \dots)$ or $x^2(\dots + 7x^3)$	M1	
	$2x$ or $35x^4$	M1dep	oe eg $2 \times x^1$ or $7 \times 5x^{5-1}$
	$2x + 35x^4$ or $x(2 + 35x^3)$	A1	terms in either order
	Additional Guidance		
	Accept correct use of product or quotient rule		
	$x^2(1 + 7x^3)$ and $2x(21x^2)$		M1M0

Q	Answer	Mark	Comments
24	Alternative method 1		
	$AOC = 360 - 90 - 90 - 34$ or 146	M1	oe eg $180 - 34$
	reflex $AOC = 360 -$ their 146 or 214 or $ADC =$ their $146 \div 2$ or 73	M1dep	oe
	107	A1	
	Alternative method 2		
	POC or $POA = 180 - 90 - 34 \div 2$ or 73	M1	oe eg $90 - 17$
	$ADC =$ their 73	M1dep	oe
	107	A1	
	Alternative method 3		
	Reflex angle $AOC = 2x$ or obtuse angle $AOC = 360 - 2x$	M1	oe
	$360 - 2x + 90 + 90 + 34 = 360$ or $2x = 214$	M1dep	oe eg $360 - 2x + 34 = 180$
	107	A1	
	Alternative method 4		
	PAC or $PCA = (180 - 34) \div 2$ or 73	M1	oe
	$ADC =$ their 73	M1dep	using the alternate segment theorem
	107	A1	

Additional Guidance continues on the next page

Q	Additional Guidance	
24 cont	Up to M2 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts	
	Angles may be shown on diagram	
	Ignore any reasons given	
	In alt 3 allow eg angle $AOC = 2x$ unless contradicted by the diagram eg obtuse angle AOC is marked $2x$	
	A correct full method without angles identified scores M2	
	$PAC = (180 - 34) \div 2 = 73$ and $CAO = 90 - 73 = 17$ and $AOC = 180 - 2 \times 17$	M1

Q	Answer	Mark	Comments
25(a)	Alternative method 1		
	$V = kh^3$	M1	oe equation implied by $2500 = 1000k$ oe any letter for k other than V or h
	$(k =) 2500 \div 10^3$ or $(k =) 2.5$ or $(k =) \frac{5}{2}$	M1dep	oe
	$V = 2.5h^3$ or $V = \frac{5}{2}h^3$	A1	oe equation
	Alternative method 2		
	$kV = h^3$	M1	oe equation implied by $2500k = 1000$ oe any letter for k other than V or h
	$(k =) 10^3 \div 2500$ or $(k =) 0.4$ or $(k =) \frac{2}{5}$	M1dep	oe
	$\frac{2}{5}V = h^3$	A1	oe equation
	Additional Guidance		
	Alt 1 $(k =) 2.5$ or $(k \propto) 2.5$ with no incorrect working		M1M1
	Condone use of $\propto$ instead of $=$ throughout for up to M2 eg Alt 1 $V \propto kh^3$ $k \propto 2.5$ $V \propto 2.5h^3$		M1 M1 A0
	$V \propto h^3$ is M0 unless recovered		

Q	Answer	Mark	Comments
25(b)	Alternative method 1 – if using alt 1 in (a)		
	$\sqrt[3]{\frac{1280}{2.5}}$ or $\sqrt[3]{\frac{1280}{\text{their } k}}$	M1	oe eg $10 \times \sqrt[3]{\frac{1280}{2500}}$ substitutes $V = 1280$ and rearranges to the form $h =$ ft their k and equation from (a) provided using direct or inverse proportion with h^3
	8	A1ft	ft their k and equation from (a) provided using direct or inverse proportion with h^3
	Alternative method 2 – if using alt 2 in (a)		
	$\sqrt[3]{0.4 \times 1280}$ or $\sqrt[3]{\text{their } k \times 1280}$	M1	oe eg $10 \times \sqrt[3]{\frac{1280}{2500}}$ substitutes $V = 1280$ and rearranges to the form $h =$ ft their k and equation from (a) provided using direct or inverse proportion with h^3
	8	A1ft	ft their k and equation from (a) provided using direct or inverse proportion with h^3
	Additional Guidance		
	$h \propto 8$ on answer line		M1A0
	$V = 2500000h^{-3}$ in (a) and 12.5 in (b)		M1A1ft

Q	Answer	Mark	Comments
26(a)	<p>Tuesday Wednesday</p> <pre> graph LR T_rain[0.7] -- rain --> W_rain[0.7] T_rain -- no rain --> W_no_rain[0.3] T_no_rain[0.3] -- rain --> W_rain2[0.2] T_no_rain -- no rain --> W_no_rain2[0.8] W_rain -- rain W_rain -- no rain W_rain2 -- rain W_rain2 -- no rain </pre>	B2	oe fraction, decimal or percentage B1 correct probabilities on any one pair of branches

Q	Answer	Mark	Comments
26(b)	Alternative method 1		
	their $0.7 \times \text{their } 0.3$ or 0.21 or their $0.3 \times \text{their } 0.2$ or 0.06	M1	oe fraction, decimal or percentage ft their tree diagram provided probabilities are > 0 and < 1
	their $0.7 \times \text{their } 0.3$ + their $0.3 \times \text{their } 0.2$ or $0.21 + 0.06$	M1dep	oe ft their tree diagram provided probabilities are > 0 and < 1
	0.27	A1ft	oe fraction, decimal or percentage ft their tree diagram provided probabilities are > 0 and < 1
	Alternative method 2		
	their $0.7 \times \text{their } 0.7$ or 0.49 or their $0.3 \times \text{their } 0.8$ or 0.24	M1	oe fraction, decimal or percentage ft their tree diagram provided probabilities are > 0 and < 1
	$1 - \text{their } 0.7 \times \text{their } 0.7$ – their $0.3 \times \text{their } 0.8$ or $1 - 0.49 - 0.24$	M1dep	oe ft their tree diagram provided probabilities are > 0 and < 1
	0.27	A1ft	oe fraction, decimal or percentage ft their tree diagram provided probabilities are > 0 and < 1

Q	Answer	Mark	Comments
27	$\frac{60}{360} \times 2 \times \pi \times 12$ or 4π or $\frac{60}{360} \times 2 \times \pi \times (12 + 4)$ or $\frac{16}{3}\pi$ or $5\frac{1}{3}\pi$	M1	oe
	$\frac{60}{360} \times 2 \times \pi \times 12$ or 4π and $\frac{60}{360} \times 2 \times \pi \times (12 + 4)$ or $\frac{16}{3}\pi$ or $5\frac{1}{3}\pi$ or $\frac{28}{3}\pi$ or $9\frac{1}{3}\pi$ or [37.3, 37.33]	M1dep	oe eg $\frac{60}{360} \times 2 \times \pi \times 12$ and $\frac{60}{360} \times 2 \times \pi \times 12 \times \frac{4+12}{12}$ or $\frac{60}{360} \times 2 \times \pi \times (12 + 4)$ and $\frac{60}{360} \times 2 \times \pi \times (12 + 4) \times \frac{12}{4+12}$
	$\frac{28}{3}\pi + 8$ or $a = 28$ and $b = 8$	A1	
	Additional Guidance		
	Ignore area calculations		
	For the M marks, allow [12.56, 12.6] for 4π , [16.74, 16.8] for $\frac{16}{3}\pi$ and [29.3, 29.33] for $\frac{28}{3}\pi$		
	$\frac{16}{3}\pi - 4\pi$		M1M1
	$\frac{60}{360} \times 2 \times \pi \times 12 + 2 \times 12$		M1
	$\frac{60}{360} \times \pi \times 12$ unless recovered		M0

Q	Answer	Mark	Comments
28	$y^2 = \frac{3x}{2x-1}$	M1	
	$y^2(2x-1) = 3x$ or $2y^2x - y^2 = 3x$	M1dep	
	$2y^2x - 3x = y^2$ or $x(2y^2 - 3) = y^2$ or $\frac{y^2}{2y^2-3}$	M1dep	oe collection of terms in x eg $-2y^2x + 3x = -y^2$
	$x = \frac{y^2}{2y^2-3}$	A1	oe formula with $x =$ or $= x$ eg $x = \frac{-y^2}{-2y^2+3}$
	Additional Guidance		
	Condone $x = \frac{y^2}{2y^2-3}$ seen in working with $\frac{y^2}{2y^2-3}$ on answer line		M3A1
	$x = \frac{y^2}{2y^2-3}$ followed by further incorrect work		M3A0
	$2y^2x$ may be seen as $2xy^2$ etc		

Q	Answer	Mark	Comments
29	$\frac{\sqrt{c}}{bc}$	B1	

Q	Answer	Mark	Comments
30(a)	$\frac{3}{2}$	B1	

Q	Answer	Mark	Comments
30(b)	Area of a rectangle, trapezium or triangle that is part of the area under the graph and is bounded by one of the lines of the graph or a part of a line of the graph	M1	eg 2×3 or 6 $\frac{1}{2} \times (2 + 5) \times 2$ or 7 $\frac{1}{2} \times 1 \times 5$ or 2.5 $\frac{1}{2} \times (3 + 2.6) \times 2$ or 5.6 may be seen on diagram
	Complete method to work out the area under the graph	M1dep	eg $2 \times 3 + \frac{1}{2} \times (2 + 5) \times 2 + \frac{1}{2} \times 1 \times 5$ $2 \times 5 + \frac{1}{2} \times 2 \times 3 + \frac{1}{2} \times 1 \times 5$ $2 \times 3 + \frac{1}{2} \times (3 + 2.6) \times 2 + \frac{1}{2} \times 2.6 \times 3$
	15.5	A1	

Q	Answer	Mark	Comments
31	Alternative method 1		
	$\frac{8+3\sqrt{5}}{2+\sqrt{5}} \times \frac{2-\sqrt{5}}{2-\sqrt{5}}$	M1	oe rationalisation of their denominator may be implied by second and third mark
	$16 + 6\sqrt{5} - 8\sqrt{5} - 15$ or $16 - 2\sqrt{5} - 15$ or $1 - 2\sqrt{5}$ or $1 + 6\sqrt{5} - 8\sqrt{5}$	M1dep	terms in any order
	$4 + 2\sqrt{5} - 2\sqrt{5} - 5$ or $4 - 5$ or -1	M1dep	terms in any order dep on 1st M1 only
	M3 awarded and $-1 + 2\sqrt{5}$ or $a = -1$ and $b = 2$	A1	
	Alternative method 2		
	$2a + a\sqrt{5} + 2b\sqrt{5} + 5b$	M1	oe expanding $(2 + \sqrt{5})(a + b\sqrt{5})$
	$2a + 5b = 8$ and $a + 2b = 3$	M1dep	oe equating terms accept $a\sqrt{5} + 2b\sqrt{5} = 3\sqrt{5}$
	Correctly eliminates one unknown	M1dep	eg $2(3 - 2b) + 5b = 8$ $5b - 4b = 8 - 6$
	M3 awarded and $-1 + 2\sqrt{5}$ or $a = -1$ and $b = 2$	A1	
	Additional Guidance		
	Allow eg 3×5 for 15 or 2^2 for 4 for all 4 marks		
	Allow $(\sqrt{5})^2$ for 5 and $(-)(\sqrt{5})^2$ or $(-)(3\sqrt{25})$ for $(-)(15)$		

Q	Answer	Mark	Comments
32	Alternative method 1		
	$\frac{243}{16}\pi = \frac{4}{3}\pi r^3$ or $\frac{243}{16} = \frac{4}{3}r^3$	M1	oe
	$\frac{243}{16} \times \frac{3}{4}$ or $\frac{729}{64}$ or [11.39, 11.4]	M1dep	oe
	$\sqrt[3]{\text{their } \frac{729}{64}}$ or $\frac{9}{4}$ or 2.25 or $\sqrt[3]{\text{their } [11.39, 11.4]}$	M1dep	oe allow $\sqrt[3]{\text{their } [11.39, 11.4]}$ to be rounded or truncated to at least 1 d.p.
	$\frac{9}{4} \times 4$ or 2.25×4 or 9 or $\sqrt[3]{\text{their } [11.39, 11.4]} \times 4$	M1dep	oe implied by $9 \times 9 \times 9$ or 9^3
	729	A1	

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments
32 cont	Alternative method 2		
	$\frac{243}{16}\pi = \frac{4}{3}\pi r^3$ or $\frac{243}{16} = \frac{4}{3}r^3$	M1	oe
	$\frac{243}{16} \times \frac{3}{4}$ or $\frac{729}{64}$ or [11.39, 11.4]	M1dep	oe
	$(4r)^3$ or $64r^3$	M1	oe
	$64 \times \frac{243}{16} \times \frac{3}{4}$ or $64 \times \frac{729}{64}$ or $64 \times \text{their [11.39, 11.4]}$	M1dep	oe dep on M3
	729	A1	
	Additional Guidance		
	Up to M4 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments
33	$(x + 5)(x - 5)$	M1	oe correct factorisation
	$(2x + 3)(x - 5)$	M1	oe correct factorisation
	$\frac{x+5}{2x+3}$	A1	
	Additional Guidance		
	Condone multiplication signs for M marks		
	Condone missing final bracket for M marks		
	Correct answer followed by further work		M1M1A0

Q	Answer	Mark	Comments
34	$1 + \frac{1}{8}$ or $\frac{9}{8}$ or 1.125	M1	oe may be cubed or squared
	$x \times \left(\frac{9}{8}\right)^3 = 10.5$ or $10.5 \div \left(\frac{9}{8}\right)^3$ or $10.5 \div 1.125^3$	M1dep	oe
	7.37(4...) or 7.4	A1	oe eg $\frac{1792}{243}$
	Additional Guidance		
	For year on year calculations accept the following values 2019 9.33... or $9\frac{1}{3}$ oe 2018 [8.29, 8.3] or $\frac{224}{27}$		M1
	$10.5 \times \frac{8}{9}$ implies $\frac{9}{8}$		M1
	$10.5 \times \left(\frac{9}{8}\right)^3$		M1M0A0
	10.5×1.125 with no further correct working		M1M0A0
	Answer 7.37(4...) or 7.4 from trial and improvement		M1M1A1

Q	Answer	Mark	Comments
35	Alternative method 1 – starting at the beginning of day 1		
	$x - 36$ or $y - 11$ or $x - 45$ or $y - 38$	M1	oe may be seen in a ratio or equation
	$x - 36 = y - 11$ or $2(x - 45) = 5(y - 38)$	M1dep	oe eg $x - y = 25$ $\frac{x - 45}{y - 38} = \frac{5}{2}$
	$x - 36 = y - 11$ and $2(x - 45) = 5(y - 38)$ and correctly eliminates one unknown or $(x =) 75$ or $(y =) 50$	M1dep	oe eg $3x = 225$ $3y = 150$
	75 : 50	A1	oe eg 3 : 2
	Alternative method 2 – starting at the end of day 2		
	$h + 9$ or $p + 27$ or $h + 45$ or $p + 38$	M1	h is hardback books and p is paperback books end of day 2 any letters other than x and y may be seen in a ratio or equation
	$h + 9 = p + 27$ or $2h = 5p$	M1dep	oe eg $h - p = 18$
	$h + 9 = p + 27$ and $2h = 5p$ and correctly eliminates one unknown and correctly evaluates $h + 45$ or $p + 38$ by correct substitution or $(h + 45 =) 75$ or $(p + 38 =) 50$	M1dep	oe accept x for $h + 45$ and y for $p + 38$
	75 : 50	A1	oe eg 3 : 2

Mark scheme and Additional Guidance continue on the next page

Q	Answer	Mark	Comments
35 cont	Alternative method 3 – starting at the end of day 1		
	$h - 9$ or $p - 27$ or $h + 36$ or $p + 11$	M1	h is hardback books and p is paperback books end of day 1 any letters other than x or y may be seen in a ratio or equation
	$2(h - 9) = 5(p - 27)$	M1dep	oe eg $\frac{h-9}{p-27} = \frac{5}{2}$ may be the same letter for h and p eg $2(m - 9) = 5(m - 27)$
	$2(h - 9) = 5(p - 27)$ and $h = p$ and correctly eliminates one unknown and correctly evaluates $h + 36$ or $p + 11$ by correct substitution or $(h + 36 =) 75$ or $(p + 11 =) 50$	M1dep	oe accept x for $h + 36$ and y for $p + 11$
	75 : 50	A1	oe eg 3 : 2
	Additional Guidance		
	Up to M3 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	Ignore any incorrect simplification following a correct answer seen		
	In alt 2 the correct values of h and p are $h = 30$ and $p = 12$		
	In alt 2 the ratio may be used in the expressions for books remaining eg using $5n$ and $2n$ $5n + 9$ or $2n + 27$ or $5n + 45$ or $2n + 38$ $5n + 9 = 2n + 27$ $n = 6$ and $5n + 45 = 75$ or $2n + 38 = 50$		M1 M1 M1
	In alt 3 and the correct values of h and p are $h = 39$ and $p = 39$		
	In alt 3 the same letter other than x or y , may be used throughout eg $2(m - 9) = 5(m - 27)$		M1M1
	75 : 50 from trial and improvement		M1M1M1A1

Q	Answer	Mark	Comments
36	$(\overrightarrow{QR}) = -2\mathbf{a} + 2\mathbf{b}$ or $(\overrightarrow{RQ}) = -2\mathbf{b} + 2\mathbf{a}$	M1	oe
	$\overrightarrow{LM} = \mathbf{a} + \frac{1}{2}(-2\mathbf{a} + 2\mathbf{b})$ or $\overrightarrow{LM} = -\mathbf{a} + 2\mathbf{b} + \frac{1}{2}(-2\mathbf{b} + 2\mathbf{a})$ or $\overrightarrow{NM} = \mathbf{b} + \frac{1}{2}(-2\mathbf{b} + 2\mathbf{a})$ or $\overrightarrow{NM} = -\mathbf{b} + 2\mathbf{a} + \frac{1}{2}(-2\mathbf{a} + 2\mathbf{b})$ or $\overrightarrow{ML} = \frac{1}{2}(-2\mathbf{b} + 2\mathbf{a}) - \mathbf{a}$ or $\overrightarrow{ML} = \frac{1}{2}(-2\mathbf{a} + 2\mathbf{b}) - 2\mathbf{b} + \mathbf{a}$ or $\overrightarrow{MN} = \frac{1}{2}(-2\mathbf{a} + 2\mathbf{b}) - \mathbf{b}$ or $\overrightarrow{MN} = \frac{1}{2}(2\mathbf{a} - 2\mathbf{b}) - 2\mathbf{a} + \mathbf{b}$	M1dep	allow eg $-\mathbf{a} + \mathbf{b}$ for $\frac{1}{2}(-2\mathbf{a} + 2\mathbf{b})$ provided $(\overrightarrow{QR}) = -2\mathbf{a} + 2\mathbf{b}$ and $(\overrightarrow{QM}) = -\mathbf{a} + \mathbf{b}$ or $(\overrightarrow{QR}) = -2\mathbf{a} + 2\mathbf{b}$ and $\overrightarrow{QM} = \frac{1}{2}\overrightarrow{QR}$ seen
	$\overrightarrow{LM} = \mathbf{b}$ or $\overrightarrow{ML} = -\mathbf{b}$ or $\overrightarrow{NM} = \mathbf{a}$ or $\overrightarrow{MN} = -\mathbf{a}$ and M2 awarded	A1	
	Additional Guidance		
	Up to M2 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	Non-vector methods must be complete and give all reasons		
	For the A mark, if both sides of the parallelogram are found, eg $\overrightarrow{LM}$ and $\overrightarrow{NM}$, there must be no contradiction		