Question	Answer	Marks	Guidance
1	$a = 3$	**B1**	
	$b = \frac{2}{3}$ oe	**B1**	
	$c = -4$	**B1**	
2	$rs = 6561$ isw	**3**	**B2** for $\log_3 rs = 8$ or $\log_3 (rs)^2 = 16$ **B1** for $2\log_9 s = \frac{2\log_3 s}{\log_3 9}$ soi
	Alternative 1		
	$rs = 6561$ isw	**(3)**	**B2** for $\log_9 rs = 4$ or $\log_9 (rs)^2 = 8$ **B1** for $\log_3 r = \frac{\log_9 r}{\log_9 3}$ soi
	Alternative 2		
	$rs = 6561$ isw	**(3)**	**B2** for $\log rs = 8\log 3$ or $\log rs = 4\log 9$ for any base **B1** for $\frac{\log r}{\log 3} + \frac{2\log s}{\log 9} = 8$ soi for any base
3	$\frac{dy}{dx} = \frac{1}{2}\sec^2 \frac{x}{2}$ or $\frac{1}{2\cos^2\left(\frac{x}{2}\right)}$	**2**	**M1** for $k\sec^2 \frac{x}{2}$ or $\frac{k}{\cos^2\left(\frac{x}{2}\right)}$, $k \neq \frac{1}{2}$
	$\sec^2 \frac{\pi}{6} = \frac{4}{3}$ or $\cos^2\left(\frac{\pi}{6}\right) = \frac{3}{4}$ soi	**B1**	
	$\frac{dy}{dx} = \frac{2}{3}$	**A1**	
4(a)	6435	**B1**	
4(b)	9	**B1**	
4(c)	${}^6C_2 \times {}^5C_2$ (150)	**B1**	
	${}^6C_3 \times {}^5C_3 \times {}^4C_2$ (1200)	**B1**	
	${}^6C_4 \times {}^5C_4$ (75)	**B1**	
	Total: 1425	**B1**	**Dep** on all previous **B** marks

Question	Answer	Marks	Guidance
5(a)	$AD^2 = \left(\sqrt{7}-2\right)^2 + \left(\sqrt{7}+2\right)^2$ soi, oe	**B1**	
	$AD^2 = 11 - 4\sqrt{7} + 11 + 4\sqrt{7}$ or $AD = \sqrt{11 - 4\sqrt{7} + 11 + 4\sqrt{7}}$	**B1**	This is the minimum detail that is acceptable for this mark
	Perimeter = $18\sqrt{7} + \sqrt{22} - 14$ isw	**B1**	Allow if previous **B** mark not awarded because of lack of detail.
5(b)	$\frac{1}{2}\left(8\sqrt{7} - 7 + 9\sqrt{7} - 9\right)\left(\sqrt{7}+2\right)$ oe	**B1**	
	$\frac{1}{2}\left(119 + 18\sqrt{7} - 32\right)$	**B1**	This is the minimum detail that is acceptable
	$9\sqrt{7} + \frac{87}{2}$ oe isw	**B1**	Allow if previous **B** mark not awarded because of lack of detail. Must be 2 separate terms.
	Alternative 1		
	Area of triangle = $\frac{3}{2}$	**(B1)**	
	Area of rectangle = $\left(8\sqrt{7}-7\right)\left(\sqrt{7}+2\right)$ $= 56 + 9\sqrt{7} - 14$	**(B1)**	This is the minimum detail that is acceptable
	$9\sqrt{7} + \frac{87}{2}$ oe isw	**(B1)**	Allow if previous **B** mark not awarded because of lack of detail.
	Alternative 2		
	Area of triangle = $\frac{3}{2}$	**(B1)**	
	Area of outer rectangle = $\left(9\sqrt{7}-9\right)\left(\sqrt{7}+2\right)$ $= 63 + 9\sqrt{7} - 18$	**(B1)**	This is the minimum detail that is acceptable
	$9\sqrt{7} + \frac{87}{2}$ oe isw		Allow if previous **B** mark not awarded because of lack of detail.

Question	Answer	Marks	Guidance
5(c)	$\cot\theta = \dfrac{\sqrt{7}+2}{9\left(\sqrt{7}-1\right)}$ or $\dfrac{1}{9\left(3-\sqrt{7}\right)}$ oe	B1	May have factors of 9 multiplied out
	$\dfrac{\left(\sqrt{7}+2\right)}{9\left(\sqrt{7}-1\right)} \times \dfrac{\left(\sqrt{7}+1\right)}{\left(\sqrt{7}+1\right)}$ or $\dfrac{\left(3+\sqrt{7}\right)}{9\left(3-\sqrt{7}\right)\left(3+\sqrt{7}\right)}$	M1	For rationalisation of *their* $\cot\theta$
	$\dfrac{\sqrt{7}}{18}+\dfrac{1}{6}$	A1	
	Alternative		
	$\cot\theta = \dfrac{\sqrt{7}+2}{9\left(\sqrt{7}-1\right)}$	(B1)	
	$\sqrt{7}+2 = \left(r\sqrt{7}+s\right)\left(9\left(\sqrt{7}-1\right)\right)$ $1 = -9r+9s$ $2 = 63r-9s$	(M1)	Obtain 2 simultaneous equations from *their* $\cot\theta$. Allow one error
	$\dfrac{\sqrt{7}}{18}+\dfrac{1}{6}$	(A1)	
6(a)	$5\theta = 3.75$ so $\theta = 0.75$ **AG**	B1	Allow $\theta = \dfrac{3.75}{5}$ as a starting point

Question	Answer	Marks	Guidance
6(b)	$AB^2 = 5^2 + 5^2 - (2 \times 5 \times 5\cos 1.75)$ $\sin(0.875) = \frac{0.5AB}{5}$ $\frac{AB}{\sin 1.75} = \frac{5}{\sin 0.696}$ or $DC^2 = 5^2 + 5^2 - (2 \times 5 \times 5\cos 0.75)$ $\sin(0.375) = \frac{0.5DC}{5}$ $\frac{DC}{\sin 0.75} = \frac{5}{\sin 1.196}$	**M1**	For attempt to find the length of at least one chord. May be implied by a correct length.
	$AB = 7.67(5)$ soi	**A1**	
	$DC = 3.66(3)$ soi	**A1**	
	Arc length AD or BC : 5×0.5 soi oe	**B1**	Allow unsimplified
	16.3	**A1**	

Question	Answer	Marks	Guidance
Choose one scheme to mark to the advantage of the candidate			
6(c)	$\left(\frac{1}{2}\times 5^2\left(1.75-\sin 1.75\right)\right)$ $-\left(\frac{1}{2}\times 5^2\left(0.75-\sin 0.75\right)\right)$	**M2**	**M2** for a fully correct method with no extra terms **M1** for attempt at the area of at least one segment – may be implied by different methods
	8.7	**A1**	
	Alternative 1		
	Triangle *ODC* + sectors *OCB* and *AOD* only $\left(\frac{1}{2}\times 5^2 \times \sin 0.75\right)+2\left(\frac{1}{2}\times 5^2\times 0.5\right)$	**(M1)**	
	Triangle *OAB* $\frac{1}{2}\times 5^2\times\sin 1.75$	**(M1)**	
	8.7	**(A1)**	
	Alternative 2		
	Area of trapezium formed by Triangle *ODC* – triangle *OPQ* = $\left(\frac{1}{2}\times 5^2\times\sin 0.75\right)-\left(\frac{1}{2}\times OP^2\times\sin 0.75\right)$	**(M1)**	The points *P* and *Q* are where the lines *OD* and *OC* meet *AB*. Candidates may have different labels
	Area of *APD* and *BQC* = $2\times\left(\left(\frac{1}{2}\times 5^2\times 0.5\right)-\left(\frac{1}{2}\times 5\times OP\times\sin 0.5\right)\right)$	**(M1)**	
	8.7	**(A1)**	
	Alternative 3		
	Area of trapezium *ABCD* $=\frac{1}{2}\left(AB+CD\right)\times 1.45$	**(M1)**	Allow 8.21
	area of 2 remaining shaded segments $2\times\left(\left(\frac{1}{2}\times 5^2\times 0.5\right)-\left(\frac{1}{2}\times 5^2\times\sin 0.5\right)\right)$	**(M1)**	Allow **M1** for one segment
	8.7	**(A1)**	

Question	Answer	Marks	Guidance
7(a)	$2x^2 - x(3x-2) + (3x-2)^2 = 2$ or $2\left(\frac{y+2}{3}\right)^2 - y\left(\frac{y+2}{3}\right) + y^2 = 2$	**M1**	For a quadratic equation in one variable
	$4x^2 - 5x + 1 = 0$ oe or $4y^2 + y - 5 = 0$ oe	**A1**	Allow multiples but must be a 3 term equation = 0
	$x = \frac{1}{4}$ $x = 1$ $y = -\frac{5}{4}$ $y = 1$	**2**	**A1** for each correct pair
	Midpoint: $\left(\frac{5}{8}, -\frac{1}{8}\right)$	**M1**	Allow for use of *their* coordinates
	Gradient of AB = 3	**M1**	**M1** for gradient of AB = 3 Allow for use of *their* coordinates
	Perpendicular gradient: $-\frac{1}{3}$	**M1**	**Dep** on previous **M** mark
	Perpendicular equation: $y + \frac{1}{8} = -\frac{1}{3}\left(x - \frac{5}{8}\right)$	**M1**	Allow for *their* perp gradient and *their* midpoint
	When $y = \frac{7}{8}$, $k = -\frac{19}{8}$ or -2.375 oe	**A1**	
7(b)	$\left(\frac{29}{8}, -\frac{9}{8}\right)$ or $(3.625, -1.125)$ oe	**2**	**B1** for each coordinate
8(a)	$\dfrac{\frac{1}{3}(6x)(3x^2-5)^{-\frac{2}{3}}(x+4) - (3x^2-5)^{\frac{1}{3}}}{(x+4)^2}$ or $\frac{1}{3}(6x)(3x^2-5)^{-\frac{2}{3}}(x+4)^{-1}$ $+(3x^2-5)^{\frac{1}{3}}\left(-(x+4)^{-2}\right)$	**3**	**B1** for $\frac{1}{3}(6x)(3x^2-5)^{-\frac{2}{3}}$ soi **M1** for attempt at differentiation of a quotient or valid product **A1** for all other terms correct
	$\left(2x(x+4) - (3x^2-5)\right)$	**M1**	**M1 dep** on previous **M** mark for simplification of *their* numerator Allow one sign slip but must be dealing with two quadratic terms.
	$\dfrac{-x^2 + 8x + 5}{(3x^2-5)^{\frac{2}{3}}(x+4)^2}$	**A1**	

Question	Answer	Marks	Guidance
8(b)	$-x^2+8x+5=0$ oe, together with attempt to solve	**M1**	Allow for use of *their* quadratic numerator from part (a)
	$4\pm\sqrt{21}$	**2**	**A2** for both **A1** for $\frac{8+\sqrt{84}}{2}$ or $\frac{8-\sqrt{84}}{2}$ oe
9(a)	Velocity vector $=\begin{pmatrix}-10\\10.5\end{pmatrix}$ or $\frac{1}{2}\begin{pmatrix}-20\\21\end{pmatrix}$	**B2**	**B1** for $\left\lvert\begin{pmatrix}-20\\21\end{pmatrix}\right\rvert=29$ soi or one correct element
9(b)	$\begin{pmatrix}3\\5\end{pmatrix}+\begin{pmatrix}-10\\10.5\end{pmatrix}t$ oe	**2**	**M1 FT** on *their* velocity vector from part (a) if not correct.
9(c)	$\overrightarrow{PQ}=\begin{pmatrix}5t-4\\-3t-2\end{pmatrix}$ oe	**2**	**Dep M1** must have **M1** in part (b) for $\left(\begin{pmatrix}-1\\3\end{pmatrix}+\begin{pmatrix}-5\\7.5\end{pmatrix}t\right)-$ *their* answer to part (b) or *their* answer to part b $-\left(\begin{pmatrix}-1\\3\end{pmatrix}+\begin{pmatrix}-5\\7.5\end{pmatrix}t\right)$
	$PQ=\sqrt{(5t-4)^2+(-3t-2)^2}$	**M1**	**Dep** on previous **M** mark for using *their* $\overrightarrow{PQ}$
	$PQ=\sqrt{34t^2-28t+20}$	**A1**	
9(d)	For collision $34t^2-28t+20=0$ soi	**M1**	Need to be using *their* quadratic PQ^2 from part (c) or forming a quadratic from their $\overrightarrow{PQ}$ from part (c)
	Discriminant $=-1936$ So no real roots so no collision oe	**A1**	Discriminant must be correct, but allow unsimplified
10(a)(i)	$d=2\sin 2x$ soi	**B1**	
	$S_n=\frac{n}{2}\left(6\sin 2x+2(n-1)\sin 2x\right)$ or $S_n=\frac{n}{2}\left(3\sin 2x+(2n+1)\sin 2x\right)$	**M1**	For correct use of the sum formula with *their d*
	$n(n+2)\sin 2x$	**A1**	

Question	Answer	Marks	Guidance
10(a)(ii)	$-220\sqrt{3}$ isw	2	Allow 'starting again' **M1** for use of *their* answer to (a), but must be a correct method, $\sin\left(\frac{4\pi}{3}\right)$ needs to be evaluated to give an exact answer.
10(b)(i)	$2^{n-1}\ln 2y$ or $(\ln 2y)2^{n-1}$ or $\ln(2y)^{2^{n-1}}$	**B2**	**B1** for $r = 2$
10(b)(ii)	$\ln 2y\frac{(1-\textit{their } r^n)}{(1-\textit{their } r)}$	**M1**	For correct use of sum formula with *their* non-logarithmic r
	$(2^n - 1)\ln 2y$ or $-1(1-2^n)\ln 2y$ or $\ln(2y)^{2^n-1}$ or $-\ln 2y + 2^n \ln 2y$ oe isw when appropriate	**A1**	**A0** if denominator is still present.
10(c)	$-\frac{3}{8} < w < \frac{5}{8}$ $-0.375 < w < 0.625$ $w < \frac{5}{8}$ **and** $w > -\frac{3}{8}$	3	**B2** for $\left\lvert 2w - \frac{1}{4} \right\rvert < 1$ or $-1 < 2w - \frac{1}{4} < 1$ or $\frac{5}{8}$ **and** $-\frac{3}{8}$ seen **B1** for $r = 2w - \frac{1}{4}$. May be seen in the sum to infinity formula
11(a)	$x + 2x\ln x$	2	**M1** for attempt at product rule Allow unsimplified for **A1**
11(b)	$mx^2 \ln x$	**M1**	**Mark final answer** **Dep** on **M1** in part (a)
	$\int x\ln x \, dx = \frac{1}{2}x^2 \ln x - \frac{x^2}{4} + c$ oe	2	**A1** for $\frac{1}{2}x^2 \ln x$ oe **A1** for $-\frac{x^2}{4} + c$ oe