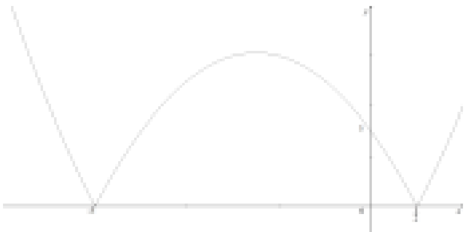
Question	Answer	Marks	Guidance
1	$(3\ln 5x-1)(\ln 5x+1)=0$ $\ln 5x=\frac{1}{3}$, $\ln 5x=-1$	**M1**	For recognition of a quadratic in $\ln 5x$ and attempt to solve to obtain $\ln 5x=k$
	$x=\frac{1}{5}e^{\frac{1}{3}}$, $\frac{\sqrt[3]{e}}{5}$, $e^{\frac{1}{3}-\ln 5}$ oe $x=\frac{1}{5e}$, $\frac{e^{-1}}{5}$, $e^{-1-\ln 5}$ oe	**3**	**Dep M1** for dealing with *their* $\ln 5x=k$ correctly once **A1** for $x=\frac{1}{5}e^{\frac{1}{3}}$ oe isw **A1** for $x=\frac{1}{5e}$ oe isw
2	$a=3$	**B1**	
	$b=\frac{1}{2}$	**B1**	
	$c=4$	**B1**	
3(a)	Gradient of line perp to $AB=-\frac{3}{4}$	**B1**	
	Mid-point of AB $(-1, 10)$ soi	**B1**	
	$y-10=-\frac{3}{4}(x+1)$ soi	**M1**	For attempt at straight line using *their* perp gradient and *their* mid-point
	$a-10=-\frac{3}{4}(7+1)$ $a=4$	**A1**	Allow $y=4$
3(b)	$(-9, 16)$	**2**	**B1** for $x=-9$ **B1 FT** on *their a*, **dep** on **M1** from **(a)** for $y=16$ or $20-$*their a* **B1** for $-9,16$
4(a)	$2\left(x+\frac{5}{4}\right)^2-\frac{49}{8}$	**3**	**B1** for $b=\left(x+\frac{5}{4}\right)^2$ or $(x+1.25)^2$ **B1** for $c=-\frac{49}{8}$ or -6.125

Question	Answer	Marks	Guidance
4(b)	$\left(-\frac{5}{4}, -\frac{49}{8}\right)$ oe	2	**B1** for $-\frac{5}{4}$ as part of a set of coordinates or $x=-\frac{5}{4}$, **FT** on $-$ *their b* **B1** for $-\frac{49}{8}$ as part of a set of coordinates or $y=-\frac{49}{8}$ **FT** on *their c* Need to be using *their* answer to **(a)** and not using differentiation as 'Hence'. **B1** for $-\frac{5}{4}, -\frac{49}{8}$
4(c)		3	**B1** for correct shape, with maximum in the second quadrant and cusps on the x-axes and reasonable curvature for $x<-3$ and $x>0.5$. **B1** for $(-3,\ 0)$ and $(0.5,\ 0)$ either seen on the graph or stated, must have attempted a correct shape **B1** for $(0,\ 3)$ either seen on the graph or stated, must have attempted a correct shape
4(d)	$\frac{49}{8}$ oe	B1	**FT** on *their* $\lvert c \rvert$ from **(a)** Allow $\frac{49}{8}$ from other methods
5(a)	$\begin{pmatrix}-4\\3\end{pmatrix}t$ or $\begin{pmatrix}0\\0\end{pmatrix}+\begin{pmatrix}-4\\3\end{pmatrix}t$ oe	B1	
5(b)	$\begin{pmatrix}12\\6\end{pmatrix}+\begin{pmatrix}-5\\8\end{pmatrix}t$ or $\begin{pmatrix}12-5t\\6+8t\end{pmatrix}$	B1	

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5(c)	$\overrightarrow{PQ} = \begin{pmatrix}12\\6\end{pmatrix} + \begin{pmatrix}-5\\8\end{pmatrix}t - \begin{pmatrix}-4\\3\end{pmatrix}t$	**M1**	For $their(b) - their(a)$, or $their(a) - their(b)$ Allow unsimplified. Both vectors must be in terms of t
	$\begin{pmatrix}12-t\\6+5t\end{pmatrix}$ soi	**B1**	
	$\left\|\left(\overrightarrow{PQ}\right)^2\right\| = (12-t)^2 + (6+5t)^2$ $\left\|\left(\overrightarrow{PQ}\right)^2\right\| = 26t^2 + 36t + 180$	**A1**	Allow **FT** for use of modulus with $\begin{pmatrix}t-12\\-6-5t\end{pmatrix}$ and simplification to obtain the given result.
5(d)	Attempt to solve or consider the discriminant of $26t^2 + 36t + 180 = 0$	**M1**	Must be using the equation from part (c) as 'Hence'.
	Conclusion from either $36^2 - 4(26)(180) < 0$ or $t > 0$	**A1**	Must have stated somewhere that $\left\|\left(\overrightarrow{PQ}\right)^2\right\| = 0$ oe has been considered not just $\left\|\left(\overrightarrow{PQ}\right)^2\right\|$.
6(a)(i)	$a = 10,\ \ 6 = \frac{a}{1-r}$ $10 = 6 - 6r$	**M1**	For use of first term and sum to infinity to obtain an equation in r only
	$r = -\frac{2}{3}$	**A1**	
6(a)(ii)	$S_7 = 10\frac{\left(1-(their\ r)^7\right)}{1-\ their\ r}$	**M1**	For sum formula with $\|their\ r\| < 1$.
	$S_7 = 6.35$	**A1**	
6(b)(i)	$\log_x 3$	**B1**	
6(b)(ii)	$S_n = \frac{n}{2}\left(2\log_x 3 + (n-1)\log_x 3\right)$	**M1**	For use of sum formula with *their* (i)
	$\frac{n}{2}(n+1)\log_x 3,\ \frac{n}{2}\log_x 3^{n+1},\ \frac{n+1}{2}\log_x 3^n$	**A1**	Allow other similar equivalents
6(b)(iii)	$\frac{n}{2}(n+1) = 3081$	**M1**	For a correct attempt to solve *their* (ii) $= 3081\log_x 3$ to obtain an answer for n. Must be a 3 term quadratic in n only.
	$n = 78$	**A1**	

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6(b)(iv)	$1027 = \frac{78}{2}(79)\log_x 3$ or $3081 \log_x 3$	**M1**	For using *their* 78 in a sum equation or using 3081 to obtain x
	$x = 27$	**A1**	
7(a)	$AE^2 = \left(\sqrt{17}-1\right)^2 + \left(\sqrt{17}+1\right)^2$ $= 18 + 2\sqrt{17} + 18 - 2\sqrt{17}$	**M1**	For attempt to find *AE*. Must see at least 3 terms in an expansion that is not the difference of two squares to be convinced a calculator is not being used.
	$AE = 6$	**A1**	
	Perimeter = $4\sqrt{17} + 8 + their\ AE$ $= 4\sqrt{17} + 14$	**B1**	**FT** on *their AE*
7(b)	Area = $\frac{1}{2}\left(3\sqrt{17}+7\right)\left(\sqrt{17}+1\right)$ oe $= \frac{1}{2}\left(51 + 3\sqrt{17} + 7\sqrt{17} + 7\right)$ oe	**M1**	For attempt at a trapezium or triangle and rectangle. Must see at least 3 terms in an expansion that is not the difference of two squares to be convinced a calculator is not being used. Allow one arithmetic slip.
	Area $= 29 + 5\sqrt{17}$	**A1**	
7(c)	$\tan AED = \frac{\sqrt{17}+1}{\sqrt{17}-1} \times \frac{\sqrt{17}+1}{\sqrt{17}+1}$	**M1**	For attempt at rationalisation.
	$\frac{9+\sqrt{17}}{8}$	**A1**	Must come from $\frac{18+2\sqrt{17}}{16}$ to be convinced a calculator is not being used.
7(d)	$\sec^2 AED = \tan^2 AED + 1$ $= \frac{\left(9+\sqrt{17}\right)^2}{64} + 1$ $\frac{81+17+18\sqrt{17}+64}{64}$ oe if $\frac{\left(9+\sqrt{17}\right)^2}{64}$ and 1 are considered separately.	**M1**	For use of *their* **(c)** in the correct identity and attempt to simplify to obtain a single fraction. Must see at least 3 terms in an expansion that is not the difference of two squares to be convinced a calculator is not being used. Allow one arithmetic slip
	$\frac{81+9\sqrt{17}}{32}$ oe	**A1**	cao

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8(a)(i)	$\sin x\frac{\sin x}{\cos x}+\cos x$	**B1**	
	$\frac{\sin^2 x+\cos^2 x}{\cos x}$ oe	**B1**	
	$\frac{1}{\cos x}=\sec x$	**B1**	Poor notation is B0
8(a)(ii)	$\sec\frac{\theta}{2}=4$ $\cos\frac{\theta}{2}=\frac{1}{4}$	**M1**	For use of (i) and dealing with sec to obtain $\cos\frac{\theta}{2}=\frac{1}{4}$
	$\frac{\theta}{2}=1.3181,\ \ 4.9651$ $\theta=2.64$ or 0.839π $\theta=9.93$ or 3.16π	**3**	**Dep M1** for a correct attempt to solve to obtain at least one solution for θ **A1** for one correct solution **A1** for a second correct solution and no extra solutions
8(b)	$\tan\left(y+38^\circ\right)=\frac{1}{\sqrt{3}}$ $y=172^\circ$ $y=352^\circ$	**3**	**M1** for dealing with cot and a correct attempt to obtain at least one correct solution, allow for -8° **A1** for one correct solution **A1** for a second correct solution and no extra solutions
9(a)	$(2x-1)\left(x^2-x-1\right)$	**M1**	For attempt at factorisation by observation or by algebraic long division
	$(2x-1)\left(x^2-x-1\right)$	**A1**	cao
9(b)	At A $x=\frac{1}{2}$	**B1**	
	$x^2-x-1=0$	**M1**	For a valid attempt to solve *their* quadratic equation, allow for decimal solutions
	$x=\frac{1\pm\sqrt{5}}{2}$ soi	**A1**	
	At B $x=\frac{1+\sqrt{5}}{2}$	**A1**	

Question	Answer	Marks	Guidance
9(c)	$\int \frac{1}{x}\,\mathrm{d}x = \ln x$	**B1**	
	$\left[\ln x\right]_{\frac{1}{2}}^{\frac{1+\sqrt{5}}{2}} = \ln\left(1+\sqrt{5}\right)$	**B1**	Allow $\ln\left(\frac{1+\sqrt{5}}{2}\right) - \ln\frac{1}{2}$
	$\left(\int -2x^2 + 3x + 1\right)\,\mathrm{d}x = -\frac{2}{3}x^3 + \frac{3x^2}{2} + x$	**M1**	**M1** for attempt at $-\frac{2}{3}x^3 + \frac{3x^2}{2} + x$, must have 2 correct terms.
	$\left[-\frac{2}{3}x^3 + \frac{3x^2}{2} + x\right]_0^{\frac{1}{2}}$ $= \left(-\frac{2}{3}\times\frac{1}{8}\right) + \left(\frac{3}{2}\times\frac{1}{4}\right) + \frac{1}{2}$ oe	**M1**	**Dep** for correct application of the limits 0 and $\frac{1}{2}$ and attempt to evaluate – may be implied by 0.792 or $\frac{19}{24}$.
	$\frac{19}{24}$	**A1**	
	$\ln\left(1+\sqrt{5}\right) + \frac{19}{24}$	**A1**	isw
10(a)	$\frac{(x-1)(6x)\left(2x^2+10\right)^{\frac{1}{2}} - \left(2x^2+10\right)^{\frac{3}{2}}}{(x-1)^2}$	**3**	**B1** for $\frac{3}{2}\times 4x \times \left(2x^2+10\right)^{\frac{1}{2}}$ oe **M1** for correct attempt at differentiation of a quotient **A1** for all the other terms correct
	$\left(\frac{\left(2x^2+10\right)^{\frac{1}{2}}}{(x-1)^2}\right)\left(4x^2 - 6x - 10\right)$	**2**	**A2** for all 3 terms correct in the quadratic **A1** for 2 terms correct and 1 incorrect term in the quadratic **A0** for 1 term correct or no terms correct in the quadratic

Question	Answer	Marks	Guidance
10(b)	$4x^2 - 6x - 10 = 0$ $(2x-5)(x+1) = 0$	M1	For attempt to solve *their* quadratic = 0 and obtain at least one solution or state that *their* quadratic equation has no real roots.
	$x = \frac{5}{2}$	A1	
	Rejecting $x = -1$ correctly	A1	May be implied by the statement $x > 1$.
	Discounting $\left(2x^2 + 10\right)^{\frac{1}{2}} = 0$	B1	