Question	Answer	Marks	Guidance
1	Use logarithm subtraction property to produce logarithm of quotient	**M1**	
	Factorise at least as far as $x(x^2-4)$ and $x(x-2)$ or use correct algebraic long division to obtain a quotient of $x+2$ and a remainder of 0 from correct working	**B1**	Allow B1 either before or after application of log property Allow B1 for equivalent using factorisation then use of addition rule Allow B1 for $\frac{(x+2)(x^2-2x)}{(x^2-2x)}$
	Obtain final answer $\ln(x+2)$ using correct process	**A1**	With no errors seen
		3	

Question	Answer		Guidance
2(i)	State or imply non-modular inequality $(3x-5)^2<(x+3)^2$ or corresponding equation or pair of different linear equations/inequalities	**B1**	**SC**: Allow B1 for $x<4$ from only one linear inequality
	Attempt solution of 3-term quadratic equation/inequality or of two different linear equations/inequalities	**M1**	For M1, must get as far as 2 critical values
	Obtain critical values $\frac{1}{2}$ and 4	**A1**	
	State answer $\frac{1}{2}<x<4$ or equivalent	**A1**	If given as 2 separate statements, condone omission of 'and' or $\cap$ but penalise inclusion of 'or' or $\cup$
		4	

Question	Answer	Marks	Guidance
2(ii)	Attempt to find n (not necessarily an integer so far) from $3^{0.1n} =$ or $<$ *their* positive upper value from part **(i)** or $3^{0.1n+1} =$ or $< 3 \times$ *their* positive upper value from part **(i)**	**M1**	0/2 for trial and improvement
	Conclude 12	**A1**	
		2	

Question	Answer	Marks	Guidance
3	Use product rule to differentiate $x^2 \ln y$	**M1**	Allow M1 for $2x \ln y + x^2 y^{-1}$ oe
	Obtain $2x \ln y + x^2 \times \frac{1}{y} \times \frac{\mathrm{d}y}{\mathrm{d}x}$	**A1**	
	Obtain $\ldots +2 + 5\frac{\mathrm{d}y}{\mathrm{d}x} = 0$	**B1**	B1 for $+2 + 5\frac{\mathrm{d}y}{\mathrm{d}x} = 0$, maybe implied by later work
	Substitute $x = 3$ and $y = 1$ to find value of their $\frac{\mathrm{d}y}{\mathrm{d}x}$	***M1**	Dependent on at least one $\frac{\mathrm{d}y}{\mathrm{d}x}$ present
	Obtain $\frac{\mathrm{d}y}{\mathrm{d}x} = -\frac{2}{14}$	**A1**	
	Attempt equation of line through $(3, 1)$ with gradient of normal	**DM1**	Allow one sign error
	Obtain $y = 7x - 20$ or equivalent unsimplified	**A1**	**FT** on their perpendicular gradient
		7	

Question	Answer	Marks	Guidance
4(a)	Use identity $\tan^2 3x = \sec^2 3x - 1$	**B1**	
	Integrate to obtain form $k_1 \tan 3x + k_2 x$	**M1**	
	Obtain correct $\frac{1}{3}\tan 3x - x + c$	**A1**	
		3	
4(b)	Express integrand as $e^{2x} + 4e^{-x}$	**B1**	
	Integrate to obtain form $k_3 e^{2x} + k_4 e^{-x}$	**M1**	
	Obtain correct $\frac{1}{2}e^{2x} - 4e^{-x}$	**A1**	
	Use limits to obtain $\frac{1}{2}e^2 - 4e^{-1} + \frac{7}{2}$ or similarly simplified equivalent	**A1**	
		4	

Question	Answer	Marks	Guidance
5(i)	Substitute $x = 2$ and equate to zero	**M1**	Allow synthetic division for each– must result in an equation from each division
	Substitute $x = -1$ and equate to 27	**M1**	Allow unsimplified
	Obtain $4a + 2b = -24$ and $a - b = 48$ or equivalents	**A1**	Allow one error in each equation
	Solve a relevant pair of simultaneous linear equations	**M1**	Dependent at least one M mark
	Obtain $a = 12, \quad b = -36$	**A1**	
		5	
5(ii)	Divide by $x - 2$ at least as far as the x term to obtain $5x^2 + (\textit{their } a + 10)x...$	**M1**	For synthetic division need to see 5 and *their* $a + 10$ in the bottom line
	Obtain $5x^2 + 22x + 8$	**A1**	
	Obtain $(x - 2)(5x + 2)(x + 4)$	**A1**	If solved using a calculator and then forming factors, must be correct for full marks
		3	

Question	Answer	Marks	Guidance
6(i)	Use quotient rule (or product rule) to differentiate	**M1**	Penalise missing brackets by withholding the A mark unless recovered later
	Obtain $\frac{dy}{dx} = \frac{3x^2(2-5x)-(-5)(8+x^3)}{(2-5x)^2}$ or equivalent	**A1**	
	State or imply curve crosses x-axis when $x = -2$	**B1**	
	Substitute -2 to obtain 1	**A1**	
		4	
6(ii)	Equate numerator of first derivative to zero and rearrange as far as $kx^3 = ...$ or equivalent	**M1**	
	Confirm given result $x = \sqrt{0.6x + 4x^{-1}}$ **AG**	**A1**	Condone in this part error(s) in denominator of derivative
		2	
6(iii)	Use iterative process correctly at least once	**M1**	
	Obtain final answer 1.81	**A1**	
	Show sufficient iterations to 5 sf to justify answer or show a sign change in the interval $[1.805,\ 1.815]$	**A1**	
		3	

Question	Answer	Marks	Guidance
7(i)	State or imply $\text{cosec}\,2\theta = \dfrac{1}{2\sin\theta\cos\theta}$	**B1**	
	Attempt to express left-hand side in terms of $\sin\theta$ and $\cos\theta$ only	**M1**	
	Simplify to confirm $\text{cosec}^2\theta$ **AG**	**A1**	
		3	
7(ii)	Use identity to express left-hand side in terms of $\sin 30$ or $\text{cosec}\,30$	**M1**	
	Obtain $\dfrac{2}{\sin 30}$ or $2\,\text{cosec}\,30$ and confirm 4 **AG**	**A1**	
		2	
7(iii)	Solve quadratic equation of the form $k\text{cosec}^2\dfrac{\phi}{2} + \text{cosec}\dfrac{\phi}{2} - 12 = 0$ or	***M1**	Allow sign errors
	$12\sin^2\dfrac{\phi}{2} - \sin\dfrac{\phi}{2} - k = 0$ correctly for $\text{cosec}\,\frac{1}{2}\phi$ or $\sin\frac{1}{2}\phi$ to find two values of $\sin\frac{1}{2}\phi$ or $\text{cosec}\,\frac{1}{2}\phi$ Obtain $\sin\frac{1}{2}\phi = -\frac{1}{4}, \frac{1}{3}$	**A1**	
	Use correct process to find at least one correct value of ϕ from $\sin\frac{1}{2}\phi = \pm\frac{1}{4}, \pm\frac{1}{3}$	**DM1**	Allow for any rounded or truncated value
	Obtain any two of –331.0, –29.0, 38.9, 321.1	**A1**	Allow greater accuracy
	Obtain all four values and no others between –360 and 360	**A1**	Allow greater accuracy
		5	