Question	Answer	Marks	Guidance
2(a)	$\frac{d}{dx}(-\ln\cos x)=\tan x$	B1	Finds first derivative.
	$\frac{d}{dx}(\tan x)=\sec^2 x$	B1	Finds second derivative.
	$\frac{y''(0)}{2!}=\frac{1}{2}$	M1 A1	Evaluates second derivative at zero. Accept $\frac{1}{2}x^2$.
		4	

Question	Answer	Marks	Guidance
2(b)	$\int_0^{\frac{1}{4}\pi}\sqrt{1+\tan^2 x}\ dx$	M1	Forms correct integral
	$=\int_0^{\frac{1}{4}\pi}\sec x\ dx$	A1	
	$=\left[\ln\left(\tan\left(\frac{1}{2}x+\frac{1}{4}\pi\right)\right)\right]_0^{\frac{1}{4}\pi}$	M1	Integrates (answer given in List MF19). Accept $\ln(\sec x+\tan x)$.
	$\ln\tan\left(\frac{3}{8}\pi\right)=0.881$	A1	Accept $\ln\left(\sqrt{2}+1\right)$.
		4	

Question	Answer	Partial Marks	Guidance
4(a)	$\frac{d}{dx}\left(4y^3\right)=12y^2y'$	B1	Differentiates y^3 correctly.
	$\frac{d}{dx}\left((x+y)^6\right)=6(x+y)^5(1+y')$	B1	Differentiates $(x+y)^6$ correctly.
	$12\left(3^2\right)y'+6(-1)(1+y')=0\Rightarrow y'=\frac{1}{17}$	B1	Substitutes $(-4,3)$, AG.
		3	

Question	Answer	Partial Marks	Guidance
4(b)	$2y^2y''+4y(y')^2$	B1	Differentiates y^2y'.
	$+(x+y)^5y''+5(x+y)^4(1+y')^2=0$	B1 B1	Differentiates $(x+y)^5(1+y')$.
	$17y''+12\left(\frac{1}{17}\right)^2+5\times(-1)^4\times\left(\frac{18}{17}\right)^2=0\Rightarrow 17y''+\frac{96}{17}=0$	M1	Substitutes $(-4,3)$.
	$y''=-\frac{96}{289}$	A1	
		5	

Question	Answer	Marks	Guidance
3	$\frac{dy}{dx}=\frac{\frac{1}{2}e^x}{1-\frac{1}{4}e^{2x}}$	B1	
	$\frac{d^2y}{dx^2}=\frac{\left(1-\frac{1}{4}e^{2x}\right)\left(\frac{1}{2}e^x\right)-\frac{1}{2}e^x\left(-\frac{1}{2}e^{2x}\right)}{\left(1-\frac{1}{4}e^{2x}\right)^2}$	B1	
	$f'(0)=\frac{2}{3}\quad f''(0)=\frac{10}{9}$	M1	Evaluates derivatives at $x=0$.
	$f(0)=\tanh^{-1}\left(\frac{1}{2}\right)=\frac{1}{2}\ln\left(\frac{3}{2}\times 2\right)$	M1	Uses logarithmic form of $\tanh^{-1}$.
	$\frac{1}{2}\ln 3+\frac{2}{3}x+\frac{5}{9}x^2$	M1 A1	Applies $f(x)=f(0)+f'(0)x+\frac{1}{2!}f''(0)x^2$
		6	

Question	Answer	Marks	Guidance
5(a)	$-\sin y\dfrac{\mathrm{d}y}{\mathrm{d}t}=1$	M1 A1	Differentiates both sides with respect to t.
	$0<y<\pi \quad\Rightarrow\quad \sin y>0 \quad\Rightarrow\quad -\sqrt{1-\cos^2 y}\dfrac{\mathrm{d}y}{\mathrm{d}t}=1$	M1	Applies $\sin^2 y+\cos^2 y=1$.
	$\dfrac{\mathrm{d}y}{\mathrm{d}t}=-\dfrac{1}{\sqrt{1-t^2}}$	A1	AG, justifies taking positive square root.
		4	
5(b)	$\dfrac{\mathrm{d}x}{\mathrm{d}t}=\dfrac{1}{\sqrt{1+t^2}}$	B1	
	$\dfrac{\mathrm{d}y}{\mathrm{d}x}=-\sqrt{\dfrac{1+t^2}{1-t^2}}$	B1	Finds first derivative.
	$\dfrac{\mathrm{d}}{\mathrm{d}t}\left(-\sqrt{\dfrac{1+t^2}{1-t^2}}\right)=-\dfrac{t\left(1-t^2\right)^{\frac{1}{2}}\left(1+t^2\right)^{-\frac{1}{2}}+t(1+t^2)^{\frac{1}{2}}\left(1-t^2\right)^{-\frac{1}{2}}}{1-t^2}$	M1	Differentiates $\dfrac{\mathrm{d}y}{\mathrm{d}x}$ with respect to t.
	$\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}=\dfrac{\mathrm{d}}{\mathrm{d}t}\left(-\sqrt{\dfrac{1+t^2}{1-t^2}}\right)\times\dfrac{\mathrm{d}t}{\mathrm{d}x}$	M1	Applies chain rule.
	$=-\dfrac{t\left(\left(1-t^2\right)^{\frac{1}{2}}+(1+t^2)\left(1-t^2\right)^{-\frac{1}{2}}\right)}{1-t^2}\quad\left(=-\dfrac{2t}{\left(1-t^2\right)^{\frac{3}{2}}}\right)$	A1	OE (simplified).
		5	

Question	Answer	Marks	Guidance
2(a)	$\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{\mathrm{d}y}{\mathrm{d}t}\times\dfrac{\mathrm{d}t}{\mathrm{d}x}=\dfrac{1+\sinh t}{\cosh t}$	M1 A1	Applies chain rule.
		2	
2(b)	$\dfrac{\mathrm{d}}{\mathrm{d}t}\left(\dfrac{1+\sinh t}{\cosh t}\right)=\dfrac{\cosh t(\cosh t)-(1+\sinh t)\sinh t}{\cosh^2 t}=\dfrac{1-\sinh t}{\cosh^2 t}$	M1 A1	Finds $\dfrac{\mathrm{d}}{\mathrm{d}t}\left(\dfrac{\mathrm{d}y}{\mathrm{d}x}\right)$.
	$\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}=\dfrac{\mathrm{d}}{\mathrm{d}t}\left(\dfrac{\mathrm{d}y}{\mathrm{d}x}\right)\times\dfrac{\mathrm{d}t}{\mathrm{d}x}=\dfrac{1-\sinh t}{\cosh^3 t}$	M1 A1	Applies chain rule, AG.
		4	
2(c)	$y=y(0)+xy'(0)+\dfrac{x^2}{2!}y''(0)=1+x+\tfrac{1}{2}x^2$	M1 A1	Finds Maclaurin's series. M1 for $y(0)$, $y'(0)$ and $y''(0)$ evaluated. A0 if $2!$ not simplified to 2.
		2	

Question	Answer	Marks	Guidance
2(a)	$\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{\mathrm{d}y}{\mathrm{d}t}\times\dfrac{\mathrm{d}t}{\mathrm{d}x}=-\dfrac{1}{\sqrt{1-t^2}}\times\left(-t^2\right)=\dfrac{t^2}{\sqrt{1-t^2}}$	M1A1	Uses chain rule, AG.
		2	
2(b)	$\dfrac{\mathrm{d}}{\mathrm{d}t}\left(\dfrac{\mathrm{d}y}{\mathrm{d}x}\right)=\dfrac{2t\sqrt{1-t^2}+t^3\left(1-t^2\right)^{-\frac{1}{2}}}{1-t^2}$	M1A1	Applies Quotient rule.
	$\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}=\dfrac{2t\sqrt{1-t^2}+t^3\left(1-t^2\right)^{-\frac{1}{2}}}{1-t^2}\left(-t^2\right)=-2t^3\left(1-t^2\right)^{-\frac{1}{2}}-t^5\left(1-t^2\right)^{-\frac{3}{2}}$ $=-t^3\left(1-t^2\right)^{-\frac{3}{2}}\left(2\left(1-t^2\right)+t^2\right)=-t^3\left(1-t^2\right)^{-\frac{3}{2}}\left(2-t^2\right)$	M1A1	Uses chain rule.
		4	