Question Number	Scheme	Notes	Marks
7	$x = \cosh t + t, \quad y = \cosh t - t$		
(a)	$\frac{\mathrm{d}x}{\mathrm{d}t} = \sinh t + 1, \quad \frac{\mathrm{d}y}{\mathrm{d}t} = \sinh t - 1$	Correct derivatives	B1
	$\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2 + \left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^2 = \sinh^2 t + 2\sinh t + 1 + \sinh^2 t - 2\sinh t + 1$ $= 2\sinh^2 t + 2$ M1: Squares correctly, cancels and collects terms		M1
	$= 2\left(1 + \sinh^2 t\right) = 2\cosh^2 t$*	Uses $\cosh^2 t = 1 + \sinh^2 t$ to complete the proof with no errors	A1*
			(3)
(b)	$S = 2\pi\int y\,\mathrm{d}s = 2\pi\int(\cosh t - t)\sqrt{2}\cosh t\,\mathrm{d}t$	Uses $S = 2\pi\int y\,\mathrm{d}s$ with the given y and the result from part (a)	M1
	$= 2\sqrt{2}\pi\int_0^{\ln 3}\left(\cosh^2 t - t\cosh t\right)\mathrm{d}t$*	Correct proof with no errors	A1*
			(2)
(c)	$\int \cosh^2 t\,\mathrm{d}t = \int \pm\frac{1}{2} \pm \frac{1}{2}\cosh 2t\,\mathrm{d}t$	Uses $\cosh^2 t = \pm\frac{1}{2} \pm \frac{1}{2}\cosh 2t$	M1
	$\int t\cosh t\,\mathrm{d}t = t\sinh t - \int \sinh t\,\mathrm{d}t$	Attempts integration by parts the right way round on $t\cosh t$	M1
		Correct expression	A1
	$S = \left(2\sqrt{2}\pi\right)\int\left(\cosh^2 t - t\cosh t\right)\mathrm{d}t = \left(2\sqrt{2}\pi\right)\left[\frac{1}{2}t + \frac{1}{4}\sinh 2t - t\sinh t + \cosh t\right]$ A1: 2 correct terms A1: All correct		A1A1
	$(S =) 2\sqrt{2}\pi\left\{\left(\frac{1}{2}\ln 3 + \frac{10}{9} - \frac{4}{3}\ln 3 + \frac{5}{3}\right) - (1)\right\}$ dM1: Correct use of limits 0 and ln3 depends on both preceding M marks		dM1
	$S = \frac{1}{9}\sqrt{2}\pi(32 - 15\ln 3)$	cao	A1 **(7)**
			Total 12
	Alternative for (c)		
	$\int \cosh^2 t\,\mathrm{d}t = \int\left(\frac{\mathrm{e}^t + \mathrm{e}^{-t}}{2}\right)^2 \mathrm{d}t$ $= \frac{1}{4}\int\left(\mathrm{e}^{2t} + 2 + \mathrm{e}^{-2t}\right)\mathrm{d}t$	Substitutes the exponential form and attempts to square	M1
	$\int t\cosh t\,\mathrm{d}t = \frac{1}{2}\int t\left(\mathrm{e}^t + \mathrm{e}^{-t}\right)\mathrm{d}t$ $= \frac{1}{2}t\mathrm{e}^t - \frac{1}{2}\int t\mathrm{e}^t\mathrm{d}t - \left\{\frac{1}{2}t\mathrm{e}^{-t} - \frac{1}{2}\int \mathrm{e}^{-t}\mathrm{d}t\right\}$	Substitutes the exponential form and attempts integration by parts the right way round Correct expression	M1 A1
	$(S =)\left(2\sqrt{2}\pi\right)\left\{\frac{1}{4}\left(\frac{1}{2}\mathrm{e}^{2t} + 2t - \frac{1}{2}\mathrm{e}^{-2t}\right) - \frac{1}{2}t\mathrm{e}^t + \frac{1}{2}\mathrm{e}^t + \frac{1}{2}t\mathrm{e}^{-t} - \frac{1}{2}\mathrm{e}^{-t}\right\}$ A1: either integral correct A1: other integral correct but both must be in a complete expression for S		A1A1
	Depends on both M marks above	Correct use of limits 0 and ln3	dM1
	$S = \frac{1}{9}\sqrt{2}\pi(32 - 15\ln 3)$	cao	A1

	Alternative for the first 3 marks of (c)		
	$= 2\sqrt{2}\pi\int \left(\cosh^2 t - t\cosh t\right)\mathrm{d}t$ $= 2\sqrt{2}\pi\int \cosh t\left(\cosh t - t\right)\mathrm{d}t$		
	$2\sqrt{2}\pi\left(\left[\sinh t\left(\cosh t - t\right)\right] - \int \sinh t\left(\sinh t - 1\right)\mathrm{d}t\right.$		
	$2\sqrt{2}\pi\left(\left[\sinh t\left(\cosh t - t\right)\right] - \left[\cosh t\left(\sinh t - 1\right)\right] + \int \cosh^2 t\mathrm{d}t\right)$ M1 (2nd on e-PEN): Use parts twice A1 Correct expression		M1A1
	$\int \cosh^2 t\,\mathrm{d}t = \int \pm\frac{1}{2} \pm \frac{1}{2}\cosh 2t\,\mathrm{d}t$	Uses $\cosh^2 t = \pm\frac{1}{2} \pm \frac{1}{2}\cosh 2t$	M1 (1st on e-PEN)
	Rest as main scheme		