Question Number	Scheme	Notes	Marks
5	$x = 4\mathrm{e}^{\frac{1}{2}t}, \quad y = \mathrm{e}^t - t \qquad 0 \leqslant t \leqslant 4$		
	$\frac{\mathrm{d}x}{\mathrm{d}t} = 2\mathrm{e}^{\frac{1}{2}t}, \quad \frac{\mathrm{d}y}{\mathrm{d}t} = \mathrm{e}^t - 1$	Correct derivatives	B1
	NB: Allow missing d*t* in the following integration work		
	$S = (2\pi)\int y\sqrt{\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2 + \left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^2}\,(\mathrm{d}t) = (2\pi)\int (\mathrm{e}^t - t)\sqrt{\left(4\mathrm{e}^{\frac{1}{2}t}\right)^2 + \left(\mathrm{e}^t - t\right)^2}\,(\mathrm{d}t)$ $\left(= (2\pi)\int (\mathrm{e}^t - t)\sqrt{4\mathrm{e}^t + \mathrm{e}^{2t} - 2\mathrm{e}^t + 1}\,(\mathrm{d}t)\right)$ Applies the surface area formula with or w/o the 2π		M1
	$= (2\pi)\int (\mathrm{e}^t - t)(\mathrm{e}^t + 1)(\mathrm{d}t)$	Correct simplified integral Brackets must be present unless implied by subsequent work but award by implication if $(2\pi)\int (\mathrm{e}^{2t} + \mathrm{e}^t - t\mathrm{e}^t - t)(\mathrm{d}t)$ is seen	A1
	$= (2\pi)\int (\mathrm{e}^t - t)(\mathrm{e}^t + 1)(\mathrm{d}t) = (2\pi)\int (\mathrm{e}^{2t} + \mathrm{e}^t - t\mathrm{e}^t - t)(\mathrm{d}t)$ $= (2\pi)\left[\frac{1}{2}\mathrm{e}^{2t} + \mathrm{e}^t - t\mathrm{e}^t + \mathrm{e}^t - \frac{1}{2}t^2\right]$ B1: For $\int t\mathrm{e}^t\,\mathrm{d}t = t\mathrm{e}^t - \mathrm{e}^t\,(+c)$ A1: Fully correct integration (the integration may be shown as 2 separate parts and score B1A1 if both parts correct)		B1A1
	$= 2\pi\left[\frac{1}{2}\mathrm{e}^{2t} + 2\mathrm{e}^t - t\mathrm{e}^t - \frac{1}{2}t^2\right]_0^4 = 2\pi\left\{\left(\frac{1}{2}\mathrm{e}^8 + 2\mathrm{e}^4 - 4\mathrm{e}^4 - 8\right) - \left(\frac{1}{2} + 2\right)\right\}$ Applies the limits 0 and 4 Must include 2π now. If 2 integrals have been used limits must be applied to both and the results added Depends on the first M mark (and some valid integration)		dM1
	$\pi\left(\mathrm{e}^8 - 4\mathrm{e}^4 - 21\right)$	Cao	A1
			(7)
			Total 7