Question Number	Scheme	Notes	Marks
8(a)	$\frac{dx}{dy}=\frac{y}{4}$ or $2y\frac{dy}{dx}=8$ or $\frac{dy}{dx}=\left(\frac{1}{2}\right)\left(2\sqrt{2}\right)x^{-\frac{1}{2}}$ or $\left(\frac{1}{2}\right)\left(2\sqrt{2}\right)\left(\frac{2\sqrt{2}}{y}\right)$ **oe** Any correct equation in $\frac{dx}{dy}$ or $\frac{dy}{dx}$ in terms of y or x		B1
	$\left(\int\sqrt{1+\left(\frac{dx}{dy}\right)^2}\,dy=\right)\int\sqrt{1+\left(\frac{y}{4}\right)^2}\,(dy)$ or $\left(\int\sqrt{1+\left(\frac{dy}{dx}\right)^2}.\frac{dx}{dy}dy=\right)\int\sqrt{1+\left(\frac{4}{y}\right)^2}.\frac{y}{4}(dy)$ Forms $\int\sqrt{1+\left(\frac{dx}{dy}\right)^2}\,(dy)$ or $\int\sqrt{1+\left(\frac{dy}{dx}\right)^2}.\frac{dx}{dy}(dy)$ correctly with their derivative		M1
	$x=18 \Rightarrow y^2=144 \Rightarrow \beta=12,\ \alpha=24$ $\Rightarrow$ (perimeter of $R=$) $24+2\int_0^{12}\sqrt{1+\frac{y^2}{16}}\,dy$	Correct expression	A1
			(3)

(b)	$y = 4\sinh u \Rightarrow \dfrac{\mathrm{d}y}{\mathrm{d}u} = 4\cosh u$	Correct derivative. Condone $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 4\cosh u$	B1
	$\displaystyle\int \sqrt{1+\frac{y^2}{16}}\,\mathrm{d}y = \int \sqrt{1+\frac{(4\sinh u)^2}{16}}(4\cosh u)(\mathrm{d}u)$ $\left(= 4\int \cosh^2 u\,\mathrm{d}u\right)$	Full substitution, correct for their $\dfrac{\mathrm{d}y}{\mathrm{d}u}$	M1
	$\displaystyle\int \cosh^2 u\,\mathrm{d}u = \int\left(\frac{1}{2}\cosh 2u + \frac{1}{2}\right)\mathrm{d}u = \frac{1}{4}\sinh 2u + \frac{1}{2}u$ **or** $\displaystyle\int\left(\frac{\mathrm{e}^u + \mathrm{e}^{-u}}{2}\right)^2\mathrm{d}u = \int\left(\frac{\mathrm{e}^{2u}}{4} + \frac{1}{2} + \frac{\mathrm{e}^{-2u}}{4}\right)\mathrm{d}u = \frac{\mathrm{e}^{2u}}{8} + \frac{1}{2}u - \frac{\mathrm{e}^{-2u}}{8}$ **d**M1: Uses $\cosh^2 u = \pm\frac{1}{2}\cosh 2u \pm \frac{1}{2}$ and integrates to obtain $a\sinh 2u + bu$ **or** uses $k\left(\mathrm{e}^u + \mathrm{e}^{-u}\right)$ for cosh u, expands and integrates to obtain $a\mathrm{e}^{2u} + bu + c\mathrm{e}^{-2u}$ A1: Correct integration		**d**M1 A1
	Perimeter of R:		**dd**M1
	$= 24 + (2)(4)\left[\frac{1}{4}\sinh 2u + \frac{1}{2}u\right]_0^{\text{arsinh }3 = \ln\left(3+\sqrt{10}\right)}$ $= 24 + 2\left[2\sinh u\sqrt{1+\sinh^2 u} + 2u\right]_0^{\text{arsinh}3 = \ln\left(3+\sqrt{10}\right)}$ $= 24 + 2\left[(2)(3)\sqrt{1+3^2} + 2\ln\left(3+\sqrt{10}\right)\right]$	$= 24 + (2)(4)\left[\frac{\mathrm{e}^{2u}}{8} + \frac{1}{2}u - \frac{\mathrm{e}^{-2u}}{8}\right]_0^{\ln\left(3+\sqrt{10}\right)}$ $= 24 + \mathrm{e}^{2\ln\left(3+\sqrt{10}\right)} - \mathrm{e}^{-2\ln\left(3+\sqrt{10}\right)} + 4\ln\left(3+\sqrt{10}\right)$ $24 + \left(3+\sqrt{10}\right)^2 - \frac{1}{\left(3+\sqrt{10}\right)^2} + 4\ln\left(3+\sqrt{10}\right)$	
	Substitutes arsinh3 and/or $\ln\left(3+\sqrt{3^2+1}\right)$ into their expression using correct identities or correctly removes exponentials to obtain a numerical expression in constants and lns only Accept use of calculator here e.g. $\sinh(2\text{arsinh}3) = 6\sqrt{10}$		
	$24 + 12\sqrt{10} + 4\ln\left(3+\sqrt{10}\right)$ or, e.g., $4\left(6 + 3\sqrt{10} + \ln\left(3+\sqrt{10}\right)\right)$	Correct answer – any exact simplified equivalent	A1
	Note: Integration by calculator is likely to access the first two marks only		**(6)**
			Total 9
			TOTAL FOR PAPER: 75 MARKS

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