Q	Marking instructions	AO	Mark	Typical solution
16(a)	Chooses an appropriate technique to differentiate accept any evidence of product rule or quotient rule	3.1a	M1	$\frac{dy}{dx} = -e^{-x}(\sin x + \cos x) + e^{-x}(\cos x - \sin x)$ $= -2e^{-x}\sin x$
	Differentiates fully correctly	1.1b	A1	
	Obtains fully correct simplified answer.	1.1b	A1	
16(b)	Uses their result from (a) in the form of $Be^{-x}\sin x$ showing an understanding of the fundamental theorem of calculus Condone missing constant.	3.1a	M1	$\int(-2e^{-x}\sin x)dx = e^{-x}(\sin x + \cos x) + k$ $\therefore \int(e^{-x}\sin x)dx = -\frac{1}{2}e^{-x}(\sin x + \cos x) + c$
	Obtains $\frac{1}{B}e^{-x}(\sin x + \cos x)$	2.1	R1F	

16 (c)(i)	Writes the area as $\frac{1}{B}\left[e^{-x}\left(\sin x+\cos x\right)\right]_0^{\pi}$ Condone missing limits	3.1a	M1	$\int_0^{\pi}\left(e^{-x}\sin x\right)dx=-\frac{1}{2}\left[e^{-x}\left(\sin x+\cos x\right)\right]_0^{\pi}$ $=-\frac{1}{2}[e^{-\pi}\left(\sin\pi+\cos\pi\right)$ $-e^{0}\left(\sin 0+\cos 0\right)]$ $=\frac{e^{-\pi}+1}{2}$
	Deduces correct limits and substitutes correctly	2.2a	A1	
	Obtains correct exact value from correct answer in part(b) CSO	1.1b	A1	
16 (c)(ii)	Substitutes correct limits for A_2 Into their $\frac{1}{B}\left[e^{-x}\left(\sin x+\cos x\right)\right]_0^{\pi}$ Or Writes $A_2=\pm\int_{\pi}^{2\pi}\left(e^{-x}\sin x\right)dx$ and uses the substitution $u=x-\pi$	1.1a	M1	$\int_{\pi}^{2\pi}\left(e^{-x}\sin x\right)dx=-\frac{1}{2}\left[e^{-x}\left(\sin x+\cos x\right)\right]_{\pi}^{2\pi}$ $=-\frac{e^{-\pi}+1}{2}e^{-\pi}$ Area $=\frac{e^{-\pi}+1}{2}e^{-\pi}$ $\frac{A_2}{A_1}=\frac{\frac{e^{-\pi}+1}{2}e^{-\pi}}{\frac{e^{-\pi}+1}{2}}=e^{-\pi}$
	Obtains correct exact area for $\pm A_2$ CSO Or Makes complete substitution $A_2=\pm\int_0^{\pi}\left(e^{-(u+\pi)}\sin\left(u+\pi\right)\right)du$	1.1b	A1	
	Forms required ratio using their exact A1 and A2, may be unsimplified Or Extracts factor of $e^{-\pi}$ and uses $\sin\left(u+\pi\right)=-\sin u$ To obtain $A_2=-e^{-\pi}\int_0^{\pi}e^{-u}\sin u\,du$	1.1a	M1	
	Completes rigorous argument, with correct limits and negatives handled correctly CSO	2.1	R1	
16 (c)(iii)	Deduces that the areas form a geometric series Accept any indication of this being geometric series	2.2a	B1	$\frac{a}{1-r}=\frac{e^{-\pi}+1}{2}\times\frac{1}{1-e^{-\pi}}$ $=\frac{1+e^{\pi}}{2\left(e^{\pi}-1\right)}$
	Uses $\frac{A_1}{1-e^{-\pi}}$	3.1a	M1	
	Obtains a value for the geometric series first term using their (c)(i)	1.1a	B1F	
	Completes rigorous argument to achieve required result in correct form. CSO AG	2.1	R1	
	Total		**16**	