12			**DR**				
			$\frac{dy}{dx}=\frac{(-8\sin 2x)(3-\sin 2x)-(4\cos 2x)(-2\cos 2x)}{(3-\sin 2x)^2}$	**M1**	**3.1a**	Attempt use of quotient rule	Correct structure, including subtraction in numerator Could be equivalent using the product rule
				A1	**1.1**	Obtain correct derivative	Award A1 once correct derivative seen even subsequently spoiled by simplification attempt

Question			Answer	Marks	AO	Guidance	
			EITHER when $x=\frac{1}{4}\pi$, gradient $=\frac{-16-0}{4}=-4$ **OR** $\frac{(-8\sin\frac{\pi}{2})(3-\sin\frac{\pi}{2})-(4\cos\frac{\pi}{2})(-2\cos\frac{\pi}{2})}{(3-\sin\frac{\pi}{2})^2}=-4$	**M1**	**2.4**	**DR** Attempt to find gradient at $\frac{1}{4}\pi$	**EITHER** State that $x=\frac{1}{4}\pi$ is being used, and show their fraction with each term (including 0) explicitly evaluated before being simplified ie $x=\frac{1}{4}\pi$, gradient $=-4$ is M0 **OR** Substitute $\frac{1}{4}\pi$ into their derivative and evaluate
			gradient of normal is $\frac{1}{4}$	**B1ft**	**2.1**	Correct gradient of normal	ft their gradient of tangent
			area of triangle is $\frac{1}{2}\times\frac{1}{16}\pi\times\frac{1}{4}\pi(=\frac{1}{128}\pi^2)$	**M1**	**2.1**	Attempt area of triangle ie $\frac{1}{2}\times\frac{1}{4}\pi\times(\text{their } y)$	y coordinate could come from using equation of normal, $y=\frac{1}{4}(x-\frac{1}{4}\pi)$, or from using gradient of normal Could integrate equation of normal
			$\int\frac{4\cos 2x}{3-\sin 2x}\,dx=-2\ln\lvert 3-\sin 2x\rvert$	**M1***	**3.1a**	Obtain integral of form $k\ln\lvert 3-\sin 2x\rvert$	Condone brackets not modulus Allow any method, including substitution, as long as integral of correct form
				A1	**1.1**	Obtain correct integral	Possibly with unsimplified coefficient
			$\int_0^{\frac{1}{4}\pi}\frac{4\cos 2x}{3-\sin 2x}\,dx=(-2\ln 2)-(-2\ln 3)$	**M1d***	**2.1**	Attempt use of limits	Using $\frac{1}{4}\pi$ and 0; correct order and subtraction (oe if substitution used) Must see a minimum of $-2\ln 2+2\ln 3$
			$2\ln 3-2\ln 2=\ln 9-\ln 4=\ln\frac{9}{4}$ OR $2\ln 3-2\ln 2=2\ln\frac{3}{2}=\ln\frac{9}{4}$	**A1**	**1.1**	Correct area under curve	Must be exact At least one log law seen to be used before final answer

Question			Answer	Marks	AO	Guidance	
			hence total area is $\ln\frac{9}{4}+\frac{1}{128}\pi^2$ **A.G.**	**A1**	**2.1**	Obtain correct total area	Any equivalent exact form AG so method must be fully correct A0 if the gradient of – 4 results from an incorrect derivative having been used A0 if negative area of triangle not dealt with convincingly
				[10]			
13	**(i)**	**(a)**	$\frac{\mathrm{d}N}{\mathrm{d}t}=\frac{k}{N}$	**B1**	**3.3**	State correct differential equation	Or $\frac{\mathrm{d}N}{\mathrm{d}t}=\frac{1}{k'N}$ or equiv with k on LHS
				[1]			
		(b)	$kt=\int N\mathrm{d}N$ $kt=\frac{1}{2}N^2+c$	**M1***	**2.1**	Attempt integration	Obtain equation of form $at = bN^2 + c$ Condone no + c
			$0=80000+c\Rightarrow c=-80000$	**M1d***	**3.4**	Attempt c from (0, 400)	Substitute (0, 400) into their equation containing c and k Could give value for c, or could result in an equation involving both c and k depending on structure
			$k=96800-80000=16800$	**M1d***	**3.4**	Attempt k from (1, 440)	Substitute (1, 440) into their equation containing c (possibly now numerical) and k If c is numerical then value of k must be attempted If this gives second equation in c and k then the equations need to be solved simultaneously for c and k to award M1
			$N=\sqrt{(33600t+160000)}$	**A1**	**1.1**	Correct equation for N	N must be the subject of the equation