Question			Answer	Marks	AO	Guidance	
11	(a)		$\cos 2x = 1$	**M1**	3.1a	Set $\cos 2x = 1$ soi	$1 - \cos 2x = 0$, then $x = 0$, would imply **M1** Allow $\cos 2x \geq 1$, but not $\cos 2x \leq 1$ (unless recovered by final answer) Allow $\cos 2x \neq 1$ if considering the values that x cannot take
			$x = 0, \pm\pi, \ldots$ $x = k\pi$ for $k \in \mathbb{Z}$	**A1** **[2]**	2.5	Identify all multiples of π, including negatives	Allow any clear notation, but must include negative integers as well eg $x = 0, \pm\pi, \pm 2\pi \ldots$ (allow 'etc' for '…') Condone working in degrees, as long as final answer is in radians

Question			Answer	Marks	AO	Guidance	
11	**(b)**		$\dfrac{\mathrm{d}y}{\mathrm{d}x}=\dfrac{10\sin 2x}{1-\cos 2x}$	**M1**	1.1	Attempt to differentiate	Obtain $\dfrac{k\sin 2x}{1-\cos 2x}$, or unsimplified equiv Other derivatives may be seen if trig identities, or log laws, used before differentiation; allow coefficient errors only Could use implicit differentiation on $1-\cos 2x = \mathrm{e}^{\frac{1}{5}y}$ oe to obtain $a\sin 2x = b\mathrm{e}^{\frac{1}{5}y}\dfrac{\mathrm{d}y}{\mathrm{d}x}$
			$\dfrac{10\sin 2x}{1-\cos 2x}=0$ $\sin 2x = 0$	**M1**	1.1	Equate their derivative to 0 and attempt to solve for a non-zero x value	Allow **M1** as long as their numerator involves a trig term Allow **M1** if working in degrees
			$x = \frac{1}{2}\pi$	**A1**	1.1	Obtain $x = \frac{1}{2}\pi$ only	Must be exact **A0** if $x = 0$ also given in final answer
			$y = 5\ln 2$	**A1**	1.1	Obtain $y = 5\ln 2$ (or $\ln 32$)	Must be exact, simplified, and from $x = \frac{1}{2}\pi$ Allow **A1** if $5\ln 2$ comes from 90°
				[4]			
11	**(c)**	**(i)**	$\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}=$ $\dfrac{(20\cos 2x)(1-\cos 2x)-(10\sin 2x)(2\sin 2x)}{(1-\cos 2x)^2}$ OR $(20\cos 2x)\mathrm{e}^{-\frac{1}{5}y}+(10\sin 2x)\left(-\dfrac{1}{5}\mathrm{e}^{-\frac{1}{5}y}\right)\dfrac{\mathrm{d}y}{\mathrm{d}x}$	**M1***	3.1a	Attempt differentiation using an appropriate method on their first derivative	Starting with $\dfrac{k\sin 2x}{1-\cos 2x}$, or a multiple of any other correct first derivative, including eg $k\cot x$ Must be correct structure for the differentiation method being attempted, allowing coefficient errors only Could use implicit differentiation on $\dfrac{\mathrm{d}y}{\mathrm{d}x}=10\sin 2x\times \mathrm{e}^{-\frac{1}{5}y}$

Question			Answer	Marks	AO	Guidance	
				A1	**2.1**	Any correct derivative, including unsimplified	If using implicit differentiation then **A1** can be awarded if $\frac{\mathrm{d}y}{\mathrm{d}x}$ is still present
			$=\dfrac{20\cos 2x-20\cos^2 2x-20\sin^2 2x}{(1-\cos 2x)^2}$ $=\dfrac{20\cos 2x-20}{(1-\cos 2x)^2}$ $\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}=\dfrac{-20(1-\cos 2x)}{(1-\cos 2x)^2}=\dfrac{-20}{1-\cos 2x}$	**M1d***	**2.1**	Attempt to simplify their second derivative using at least one trigonometric identity correctly	Only award **M1** for trig identities used after differentiation
			$\dfrac{-20}{1-\cos 2x}=\dfrac{-20}{e^{\frac{1}{5}y}}=-20e^{-\frac{1}{5}y}$ OR $20e^{-\frac{1}{5}y}=\dfrac{20}{e^{\frac{1}{5}y}}=\dfrac{20}{1-\cos 2x}$	**M1**	**2.4**	Correctly replace $1-\cos 2x$ with $e^{\frac{1}{5}y}$ or vice versa	Used either in their second derivative or in the given answer If using implicit differentiation then the M1 will be awarded before the differentiation attempt
			$\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}=-20e^{-\frac{1}{5}y}$ $\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}+20e^{-\frac{1}{5}y}=0.$ **A.G.**	**A1** **[5]**	**2.1**	Obtain / confirm given answer www	Penalise any clearly incorrect equations, but allow BOD if denominator disappears (eg when using trig identities) but then reappears when relevant

Question			Answer	Marks	AO	Guidance	
11	(c)	(ii)	$20\mathrm{e}^{-\frac{1}{5}y} > 0$ for all y, so $\frac{\mathrm{d}^2 y}{\mathrm{d}x^2} < 0$ for all x, hence stationary points are all maxima	B1 **[1]**	2.2a	Correct conclusion, with justification	Refer to the exponential term being positive, hence second derivative must be negative, hence maxima Could refer to e^k not $\mathrm{e}^{-\frac{1}{5}y}$ Could refer to the **correct** second derivative of $\frac{-20}{1-\cos 2x}$ and explain why this is always negative, hence maxima (so no need to refer to exponential term with this approach)