Question			Answer	Marks	AO	Guidance	
				[4]			
12	(a)		$u = 3x^2$, $y = a^u$ $u' = kx$, $y' = a^u \ln a$	M1	1.1a	Attempt use of chain rule, with $y' = a^u \ln a$	Correct use of chain rule, with a^u correctly differentiated No credit for just stating $\frac{\mathrm{d}}{\mathrm{d}x}\left(a^x\right) = a^x \ln a$ unless clearly used in a correct chain rule
			$\frac{\mathrm{d}y}{\mathrm{d}x} = 6xa^u \ln a$	A1	2.1	Use chain rule to obtain correct derivative	Product of their u' and y' May still be in terms of x and u
			$\frac{\mathrm{d}y}{\mathrm{d}x} = 6xa^{3x^2} \ln a$ **A.G.**	A1	2.4	Obtain correct derivative	Now fully in terms of x
				[3]			**OR** M1 – attempt differentiation of $\ln y = 3x^2 \ln a$ A1 – obtain $\frac{1}{y}\frac{\mathrm{d}y}{\mathrm{d}x} = 6x \ln a$ A1 – obtain correct derivative **A.G.** **OR** M1 – attempt differentiation of $y = \mathrm{e}^{(3\ln a)x^2}$ A1 – obtain $\frac{\mathrm{d}y}{\mathrm{d}x} = (6x \ln a)\mathrm{e}^{(3\ln a)x^2}$ A1 – obtain correct derivative **A.G.**

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	(b)		when $x = 1$, $m = 6a^3\ln a$	**B1**	**3.1a**	Correct gradient of tangent soi	
			$y - a^3 = 6a^3\ln a(x - 1)$ $0 - a^3 = 6a^3\ln a\ (\frac{1}{2} - 1)$	**M1***	**1.1a**	Use $(\frac{1}{2}, 0)$ in attempt at equation of tangent through $(1, a^3)$, or vice versa	OR $\dfrac{0-a^3}{\frac{1}{2}-1} = 6a^3\ln a$ M0 if gradient still in terms of x Allow BOD if something other than $x = 1$ was used to find the gradient
			$a^3 = 3a^3\ln a$ $a^3(3\ln a - 1) = 0$ $a = \mathrm{e}^{\frac{1}{3}}$	**M1d***	**1.1a**	Attempt to find a	Must go as far as attempting a value for a Condone cancelling by a^3 rather than factorising
				A1	**1.1**	Obtain correct value for a	Any equivalent exact form eg $a = \sqrt[3]{\mathrm{e}}$
				[4]			
	(c)		$u = 6x\ln a$, $v = a^{3x^2}$	**M1***	**3.1a**	Attempt use of product rule	On given $\dfrac{\mathrm{d}y}{\mathrm{d}x}$, with both parts a function of x If using parts as $u = 6x\,a^{3x^2}$ and $v = \ln a$, then must use product rule properly on u (but condone $\ln a$ differentiating to $\frac{1}{a}$)
			$\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2} =$	**A1**	**2.1**	At least one term correct	
			$(6\ln a)(a^{3x^2}) + (6x\ln a)(6xa^{3x^2}\ln a)$ $= a^{3x^2}(6\ln a)(1 + 6x^2\ln a)$	**A1**	**2.1**	Fully correct second derivative	

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			$\ln a > 0$ for $a > 1$ $a^{f(x)} > 0$ for all a and x $6x^2 \geq 0$, so $1 + 6x^2\ln a \geq 1$	**M1d***	**2.3**	Consider sign of each term – must consider each component of each term	Possibly factorised, or possibly considered term by term Domains not needed for the M1 Allow BOD if > not ≥
			$\dfrac{d^2y}{dx^2} > 0$ for all x hence curve is always convex	**A1** **[5]**	**2.2a**	Correct working only	Second derivative must be correct Domains must be seen Inequality signs must be correct throughout
			OR $\dfrac{dy}{dx} = 2xe^{x^2}$	**M1***		Attempt use of product rule	Substitute their a into $\dfrac{dy}{dx}$ and attempt to differentiate
			$\dfrac{d^2y}{dx^2} = 2e^{x^2} + 4x^2e^{x^2}$	**A1FT**		At least one term correct, FT their a, any a	
				A1FT		Fully correct second derivative, FT their a as long as of form e^k	Expect $6ke^{3kx^2} + 36k^2x^2e^{3kx^2}$
			$e^{x^2} > 0$ for all x, so $2e^{x^2} > 0$ $x^2 \geq 0$ for all x, so $4x^2e^{x^2} \geq 0$ hence $2e^{x^2} + 4x^2e^{x^2} > 0$	**M1d***		Consider sign of each term – must consider each component of each term	Possibly factorised, or possibly considered term by term Domains not needed for the M1 Allow BOD if > not ≥
			$\dfrac{d^2y}{dx^2} > 0$ for all x hence curve is always convex	**A1**		Correct working only	Second derivative must be correct Domains must be seen Inequality signs must be correct throughout