Question			Answer	Marks	AO	Guidance	
6	(a)		$\dfrac{dy}{dx} = (2x+3)e^{x^2+3x}$	M1	1.1a	Attempt to differentiate using the chain rule	Obtain derivative of form $f(x)e^{x^2+3x}$ Could also split into two terms and use product rule to obtain derivative of form $f(x)e^{x^2}e^{3x} + ke^{x^2}e^{3x}$ $(k \neq 0)$ **M0** if attempt to split results in sum not product
			$(2x+3)e^{x^2+3x}$	A1	1.1	Obtain correct derivative	Brackets must be seen, or implied by later work aef eg $\left(2xe^{x^2}\right)\left(e^{3x}\right) + \left(e^{x^2}\right)\left(3e^{3x}\right)$ from splitting into two terms first Could be in terms of *u*, as long as *u* clearly defined
			$(2x+3)e^{x^2+3x} = 0$ $2x + 3 = 0$ $x = -\frac{3}{2}$	A1	1.1	Equate correct derivative to 0 soi and solve to obtain $x = -\frac{3}{2}$	ISW any *y*-coordinates if given **A0** if any additional solutions for *x* Must see differentiation, so $x = -\frac{3}{2}$ with no supporting method gets no credit (as question is 'determine')

Question			Answer	Marks	AO	Guidance	
			$e^{x^2+3x} > 0$ for all x or $e^{x^2+3x} \neq 0$ or $x^2 + 3x = \ln 0$, but this is not possible	B1FT [4]	2.4	Indicate no solutions from the exponential term	FT their derivative as long as of form $f(x)e^{x^2+3x}$ or $f(x)e^u$ Allow BOD for explanations such as $e^x > 0$ for all x Must have some reason, eg 'e^{x^2+3x} is always positive', 'e^{x^2+3x} cannot be negative', 'cannot take ln of a negative number', 'not defined', 'not real', 'no solutions' **A0** for 'math error' or 'doesn't work'
6	**(a)**		**Alternative method**				
			$\ln y = x^2 + 3x$ $\frac{1}{y}\frac{dy}{dx} = 2x + 3$	**M1**		Take ln and attempt implicit differentiation	Must deal correctly with $\ln y$
			$\frac{dy}{dx} = y(2x+3)$	**A1**		Obtain correct derivative	May still have $\frac{1}{y}$ on LHS
			$2x + 3 = 0$ $x = -\frac{3}{2}$	**A1**		Equate correct derivative to 0 soi and solve to obtain $x = -\frac{3}{2}$	
			$e^{x^2+3x} \neq 0$	**B1**		Indicate no solutions from the exponential term	See main MS for guidance Could also explain why no solutions from $\frac{1}{y}$

6	**(b)**		$\frac{d^2y}{dx^2} = 2e^{x^2+3x} + (2x+3)^2 e^{x^2+3x}$	**M1**	**3.1a**	Attempt to differentiate again using the product rule correctly	Obtain derivative of form $(ax^2 + bx + c)e^{x^2+3x}$ aef
			$\frac{d^2y}{dx^2} = \left(2 + (2x+3)^2\right)e^{x^2+3x}$	**A1**	**1.1**	Obtain correct derivative	aef eg (depending on method) $2e^{x^2+3x} + 2x(2x+3)e^{x^2+3x} + 3(2x+3)e^{x^2+3x}$ or $\left(\left(2e^{x^2} + 4x^2e^{x^2}\right)e^{3x} + \left(2xe^{x^2}\right)3e^{3x}\right) + \left(6xe^{x^2}e^{3x} + 9e^{x^2}e^{3x}\right)$ Could be in terms of u, as long as u clearly defined
			convex means $\frac{d^2y}{dx^2} > 0$	**B1**	**1.2**	State, or clearly imply, correct condition at any point in proof	Must be general statement, and not just > 0 from testing the stationary point

Question			Answer	Marks	AO	Guidance	
			$(2x+3)^2 \geq 0$ hence $2 + (2x+3)^2 > 0$	**M1**	**3.1a**	Explain why correct quadratic is always positive	Could note minimum value of 2 as completed square form Could use expanded quadratic, which should be $4x^2 + 12x + 11$ If showing no real roots then must also say that it is a positive quadratic Condone > / ≥ muddles for **M1** only Could show that there are no points of inflection **and** $\frac{d^2y}{dx^2} > 0$ for at least one point
			$e^{g(x)} > 0$ for all x; quadratic > 0 for all x hence curve is always convex	**A1** **[5]**	**2.4**	Full and convincing proof to show that curve is convex for all x	www
6	**(b)**		**Alt method for first 2 marks** $\frac{dy}{dx} = y(2x+3)$ $\frac{d^2y}{dx^2} = 2y + (2x+3)\frac{dy}{dx}$	**M1**		Attempt second derivative, using implicit differentiation and the product rule	If still $\frac{1}{y}\frac{dy}{dx} = 2x+3$ then must be a correct attempt to differentiate the LHS
				A1		Obtain correct derivative	aef
			Then B1 M1 A1 as above			Will need to use $\frac{dy}{dx} = y(2x+3)$ to make further progress	