Question	Answer	Marks	Guidance
1	$a = 5$	**B1**	
	$b = 4$	**B1**	
	$c = -3$	**B1**	
2	$\tan^2\theta = \frac{1}{y+2}$ soi **or** $x = 1 + \tan^2\theta$ soi	**B1**	Must be in terms of $\tan^2\theta$
	Use of $\tan^2\theta + 1 = \sec^2\theta$ $\frac{1}{y+2} + 1 = x$ oe	**M1**	For a valid attempt to eliminate θ
	$y = \frac{1}{x-1} - 2$ or $y = \frac{3-2x}{x-1}$ oe	**2**	**Dep M1** for attempt to rearrange to obtain in the required form **A1** for a correct form
	Alternative $x = \frac{1}{\cos^2\theta}$ **and** $y + 2 = \frac{\cos^2\theta}{\sin^2\theta}$ soi	**(B1)**	
	$y + 2 = \frac{\frac{1}{x}}{1 - \frac{1}{x}}$ oe	**(M1)**	For a valid attempt to eliminate θ, making use of $\sin^2\theta + \cos^2\theta = 1$
	$y = \frac{1}{x-1} - 2$ or $y = \frac{3-2x}{x-1}$ oe	**(2)**	**Dep M1** for attempt to rearrange to obtain in the required form **A1** for a correct form
3(a)	Gradient = 4 soi	**B1**	
	Intercept = -3 soi	**B1**	
	$\lg(2y+1) = 4x^2 - 3$ oe	**M1**	For $\lg(2y+1) = \textit{their } m\left(x^2\right) + \textit{their } c$
	$y = \frac{1}{2}\left(10^{4x^2-3} - 1\right)$ or $y = \frac{\frac{10^{4x^2}}{1000} - 1}{2}$	**A1**	
3(b)	$y = 0$	**B1**	Must have at least 3 marks from part **(a)**

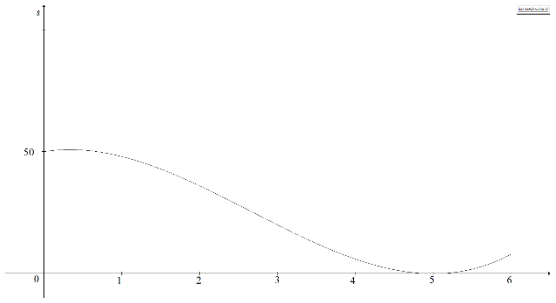
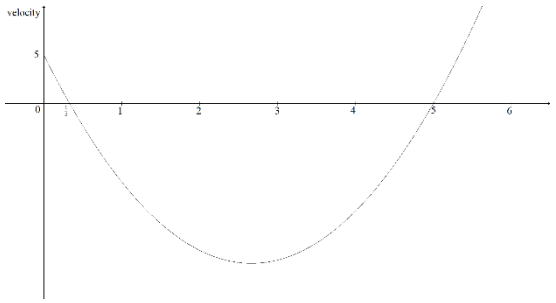
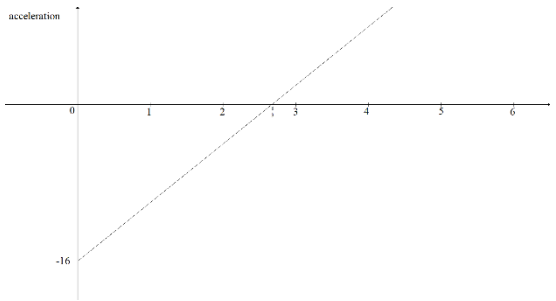
Question	Answer	Marks	Guidance
3(c)	$2=\frac{1}{2}\left(10^{4x^2-3}-1\right)$ oe and attempt to obtain x = …	**M1**	**Dep** on **M** mark in part **(a)** for use of $y=2$ in *their* $y=\frac{1}{2}\left(10^{4x^2-3}-1\right)$, $y=\frac{\frac{10^{4x^2}}{1000}-1}{2}$ or $\lg(2y+1)=4x^2-3$ and attempt to obtain x = …
	$x=(\pm)\,0.962$ or better	**A1**	
4(a)	$\frac{1}{17}\begin{pmatrix}-15\\8\end{pmatrix}$ oe	**2**	**B1** for 17 seen
4(b)	$2a+4b-12=4b-4a$ $-5+3=4a+8b$	**M1**	For equating like vectors to obtain at least one equation
	$a=2,\ b=-\frac{5}{4}$ oe	**2**	**Dep M** mark for solving *their* 2 equations to obtain both a and b
5	$\left(1+\frac{x}{6}\right)^{12}=1+2x+\frac{11x^2}{6}$	**2**	**B2** for 3 correct terms **B1** for 2 correct terms
	$(2-3x)^3=8-36x+54x^2...$	**2**	**B2** for 3 correct terms **B1** for 2 correct terms
	Term in x: $-36x+16x$	**M1**	A correct method using *their* terms or coefficients, must be considering 2 terms
	$p=-20$ soi	**A1**	
	Term in x^2: $\frac{88}{6}x^2+54x^2-72x^2$	**M1**	A correct method using *their* terms or coefficients, must be considering 3 terms
	$q=-\frac{10}{3}$ soi	**A1**	
6(a)	$\mathrm{p}\left(\frac{1}{2}\right)$: $a+4b+15=0$ oe	**B1**	For $\mathrm{p}\left(\frac{1}{2}\right)$ equated to zero
	$\mathrm{p}(2)$: $4a+b=60$ oe	**B1**	For $\mathrm{p}(2)$ equated to 120
	$a=17,\ b=-8$	**2**	**Dep M1** on both previous **B** marks, for solving *their* equations to obtain a and b **A1** for both

Question	Answer	Marks	Guidance
6(b)	-8	**B1**	**FT** on *their* **integer** b
6(c)	$\mathrm{p}'(x) = 18x^2 + 34x + 6$ $\mathrm{p}''(x) = 36x + 34$	**M1**	For attempt to differentiate *their* p(x), may be implied by correct **FT** answer
	$\mathrm{p}''(0) = 34$	**A1**	**FT** on $2\times$ *their* **integer** a
7(a)	$\dfrac{2(x-1)^2 - (x-1)(2x+3) + (2x+3)}{(x-1)^2(2x+3)}$	**M1**	Attempt at a fraction, allow with an extra $(x-1)$ term in each term of the numerator and the denominator
	$= \dfrac{8-3x}{(x-1)^2(2x+3)}$	**A1**	**AG** – must see sufficient detail to justify the given result, if an extra $(x-1)$ term involved, it must be dealt with correctly
7(b)	$\left[\ln(2x+3) - \ln(x-1) - \dfrac{1}{(x-1)}\right]_2^a$	**3**	**B1** for each correct term
	$\left(\ln(2a+3) - \ln(a-1) - \dfrac{1}{a-1}\right) - (\ln 7 - 1)$	**M1**	**Dep** on at least one ln term from integration, for applying limits correctly in *their* integral
	$\dfrac{a-2}{a-1} + \ln\left(\dfrac{2a+3}{7(a-1)}\right)$ oe	**2**	**A1** for $\dfrac{a-2}{a-1}$ or $1 - \dfrac{1}{a-1}$ **A1** for $\ln\left(\dfrac{2a+3}{7(a-1)}\right)$
	Alternative 1 final 2 marks $\dfrac{-1}{a-1} + \ln\left(\dfrac{\mathrm{e}(2a+3)}{7(a-1)}\right)$ oe	**(2)**	**A1** for $\dfrac{-1}{a-1}$ **A1** for $\ln\left(\dfrac{\mathrm{e}(2a+3)}{7(a-1)}\right)$
	Alternative 2 final 2 marks $\dfrac{a-2}{a-1} - \ln 7 + \ln\left(\dfrac{2a+3}{(a-1)}\right)$ oe	**(2)**	**A1** for $\dfrac{a-2}{a-1} - \ln 7$ or $1 - \dfrac{1}{a-1} - \ln 7$ Allow 1.946 or better for ln 7 **A1** for $\ln\left(\dfrac{2a+3}{(a-1)}\right)$

Question	Answer	Marks	Guidance
7(b)	**Alternative 3** final 2 marks $\frac{-1}{a-1} - \ln 7 + \ln\left(\frac{e(2a+3)}{(a-1)}\right)$ oe	**2**	**A1** for $\frac{-1}{a-1} - \ln 7$ Allow 1.946 or better for ln 7 **A1** for $\ln\left(\frac{e(2a+3)}{(a-1)}\right)$
8(a)	With the sisters: 70 or ${}^{8}C_{4}$ oe	**B1**	
	Without the sisters: 28 or ${}^{8}C_{6}$ oe	**B1**	
	Total: 98	**B1**	
8(b)(i)	60480	**B1**	
8(b)(ii)	The start of the password and the end of the password can each be chosen 6 ways	**B1**	6 or ${}^{3}P_{2}$ oe seen twice
	The remaining characters can be chosen in 20 ways	**B1**	20 or ${}^{5}P_{2}$ oe seen
	Total number of ways: 720	**B1**	

Question	Answer	Marks	Guidance
9	When $x = 0,\ y = \ln 2$ soi	**B1**	May be implied in later work
	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{(x+1)\frac{6x}{\left(3x^2+2\right)} - \ln\left(3x^2+2\right)}{(x+1)^2}$	**3**	**B1** for $\frac{6x}{\left(3x^2+2\right)}$ allow when seen **M1** for attempt at a quotient or product **A1** for all other terms apart from $\frac{6x}{\left(3x^2+2\right)}$ correct
	When $x = 0, \frac{\mathrm{d}y}{\mathrm{d}x} = -\ln 2$	**M1**	**Dep** on previous **M** mark for attempt to find the gradient using *their* $\frac{\mathrm{d}y}{\mathrm{d}x}$
	Equation of normal: $y - \ln 2 = \frac{1}{\ln 2}x$	**M1**	For attempt at a normal equation using *their y* (not 3 ln2) and $-\frac{1}{\textit{their}\left(-\ln 2\right)}$, must be from an attempt at differentiation
	When $y = 0,\ x = -(\ln 2)^2$	**M1**	For attempt to find the value of x when $y = 0$ using *their* normal equation
	Gradient $BC = \frac{3\ln 2}{(\ln 2)^2}$	**M1**	**Dep** on both previous **M** marks
	$\frac{3}{\ln 2}$ or $3(\ln 2)^{-1}$	**A1**	Must have correct exact working throughout

Question	Answer	Marks	Guidance
10(a)(i)	xy^2 soi	**B1**	Simplification of the left-hand side of the first equation
	$1 = \lg 10$ soi	**B1**	Simplification of right-hand side of equation
	$x - 3\left(\frac{10}{x}\right) = 13$	**M1**	For substitution of y^2 into linear equation oe and attempt to simplify
	$x^2 - 13x - 30 = 0$	**A1**	**AG** – must see sufficient detail to justify the given answer
	Alternative $y^2 = \frac{(x-13)}{3}$	**(B1)**	
	$\lg x + \lg \frac{(x-13)}{3} = 1$	**(M1)**	For attempt at substitution in the log equation
	$\frac{x(x-13)}{3} = 10$ oe	**(B1)**	
	$x^2 - 13x - 30 = 0$	**(A1)**	**AG** – must see sufficient detail to justify the given answer
10(a)(ii)	$x = 15$ only	**B1**	
	$y = \sqrt{\frac{2}{3}}$ or $\frac{\sqrt{6}}{3}$ or exact equivalent only	**B1**	isw once exact value seen
10(b)	$\log_a x + \frac{3}{\log_a x}$ or $\frac{1}{\log_x a} + 3\log_x a$	**B1**	For an appropriate change of base
	$(\log_a x)^2 - 4\log_a x + 3 = 0$ or $3(\log_x a)^2 - 4\log_x a + 1 = 0$	**M1**	For an attempt to obtain a 3-term quadratic equation in terms of $\log_a x$ or $\log_x a$, equated to zero.
	$\log_a x = 3 \quad \log_a x = 1$ or $\log_x a = \frac{1}{3}, \quad \log_x a = 1$	**M1**	**Dep** on previous **M** mark for correct solution of *their* quadratic equation
	$x = a$	**A1**	Must be from completely correct work
	$x = a^3$	**A1**	Must be from completely correct work

Question	Answer	Marks	Guidance
11(a)	$\frac{ds}{dt} = 3t^2 - 16t + 5$ oe	**2**	**M1** for attempt at differentiation of a product or expansion and differentiation with at least two out of three terms of *their* expansion differentiated correctly **A1** all correct, allow factorised
	$t = \frac{1}{3},\ t = 5$	**2**	**Dep M1** for attempt to solve *their* $\frac{ds}{dt} = 0$, must be in quadratic form **A1** for both
11(b)		**2**	**B1** for a correct curve in the first quadrant only. There must be an indication of a max point in the correct position and a min point at $(5,\ 0)$ **B1** for $(0,\ 50)$ provided basic curve shape is correct
11(c)		**2**	**B1** for a quadratic curve in the first and fourth quadrants **B1** for $(0,\ 5)$, $\left(\frac{1}{3},\ 0\right)$ or $(0.333,\ 0)$ marked and passing through $(5,\ 0)$ on the *x*-axis
11(d)(i)	Acceleration = $6t - 16$	**B1**	
11(d)(ii)		**2**	**B1** for a straight line with a positive gradient in the first and fourth quadrants, meeting the vertical axis **Dep B1** for $\left(\frac{8}{3},\ 0\right)$ or $(2.67,\ 0)$ and $(0,-16)$