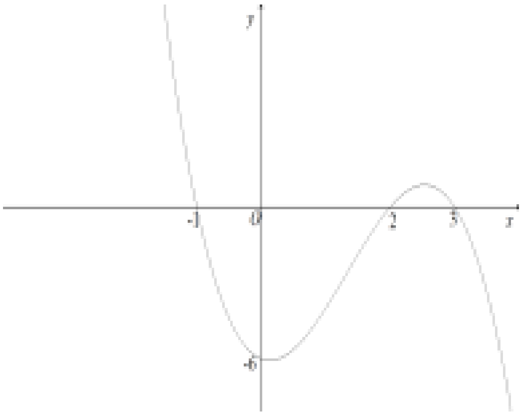
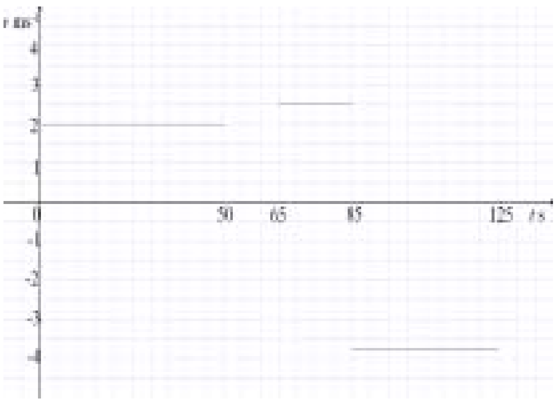
Question	Answer	Marks	Guidance
1(a)		3	**B1** for a well-drawn cubic graph in correct orientation Both arms extending beyond x-axis Maximum above x-axis **B1** for x-intercepts **B1** for y-intercept
1(b)	$x < -1$	**B1**	Dep on a cubic curve in the correct orientation and –1 correct on x-axis
	$2 < x < 3$ or $3 > x > 2$	**B1**	Dep on a cubic curve in the correct orientation and 2 and 3 correct on x-axis
2(a)	$\frac{dy}{dx} = \frac{(x^2+1)2e^{2x-3} - 2xe^{2x-3}}{(x^2+1)^2}$ oe or $\frac{dy}{dx} = \frac{2e^{2x-3}}{(x^2+1)} - \frac{2xe^{2x-3}}{(x^2+1)^2}$ oe	3	**B1** for $\frac{d}{dx}\left(e^{2x-3}\right) = 2e^{2x-3}$ seen in a quotient rule or product rule expression **M1** for correct method for differentiating a quotient or equivalent product **A1 FT** from *their* $2e^{2x-3}$
2(b)	When $x = 2$, $\frac{dy}{dx} = \frac{6e}{25}$	**M1**	For evaluation of *their* $\frac{dy}{dx}$ when $x = 2$
	$\frac{6e}{25} \times \frac{dx}{dt} = 2$ oe	**M1**	For correct substitution of *their* evaluated $\frac{dy}{dx}$ and $\frac{dy}{dt} = 2$ in a correct rates of change equation
	$\frac{dx}{dt} = \frac{25}{3e}$, $\frac{50}{6e}$	**A1**	
3(a)(i)	$x > \frac{1}{2}$	**B1**	Must be using x

Question	Answer	Marks	Guidance
3(a)(ii)	$x = 4\ln(2y-1)$ $e^{\frac{x}{4}} = 2y-1$ $y = \frac{1}{2}\left(1+e^{\frac{x}{4}}\right)$	**M1**	For full method for inverse using correct order of operations
	$f^{-1}(x) = \frac{1}{2}\left(1+e^{\frac{x}{4}}\right)$ or $f^{-1}(x) = \frac{1}{2}\left(1+\sqrt[4]{e^x}\right)$	**A1**	Must be using correct notation
	$x \in \mathbb{R}$	**B1**	
3(b)	$\sqrt{2x-3}+5=7$	**M1**	For correct order
	$x = \frac{2^2+3}{2}$	**M1**	Dep on previous M mark, for obtaining *x* by simplifying and solving using correct order of operations, including squaring
	$x = \frac{7}{2}$ or 3.5	**A1**	
4(a)(i)		**3**	**B1** For $v = 2$ for $0 \leqslant t \leqslant 50$ **B1** For $v = 2.5$ for $65 \leqslant t \leqslant 85$ **B1** For $v = 3.75$ for $85 \leqslant t \leqslant 125$ and $v = 0$ for $50 \leqslant t \leqslant 65$
4(a)(ii)	300	**B1**	
4(b)	$\frac{dx}{dt} = -18\sin\left(3t+\frac{\pi}{3}\right)$	**M1**	$\pm 18\sin\left(3t+\frac{\pi}{3}\right)$
	$\frac{d^2x}{dt^2} = -54\cos\left(3t+\frac{\pi}{3}\right)$	**M1**	$\pm 54\cos\left(3t+\frac{\pi}{3}\right)$
	-27 nfww	**A1**	

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5	$(1+x)\left(1+n\left(-\frac{x}{2}\right)+\frac{n(n-1)}{2}\left(\frac{x^2}{4}\right)...\right)$	2	**B1** For $\binom{n}{1}\left(-\frac{x}{2}\right)$ **B1** For $\binom{n}{2}\left(\frac{x^2}{4}\right)$
	$\frac{1}{4}\binom{n}{2}x^2-\frac{1}{2}\binom{n}{1}x^2=\frac{25}{4}x^2$	M1	Correctly using two terms in n to obtain an x^2 term and equating to $\frac{25}{4}x^2$ Dep on one B1
	$\frac{n(n-1)}{8}-\frac{n}{2}=\frac{25}{4}$ oe	A1	
	$n=10$ only	A1	
6(a)	$\lg y=\lg A+bx^2$	B1	Stated or may be implied by later work
	If using $\lg y=\lg A+bx^2$ as a starting point $5.25=\lg A+3.63b$ and $6.88=\lg A+4.83b$ or $5.25=\lg A+1.358(3.63)$ or $6.88=\lg A+1.358(4.83)$ OR If finding the equation of the straight line and then finding $\lg A$ and b by inspection $\lg y-6.88=1.358(x^2-4.83)$ or $\lg y-5.25=1.358(x^2-3.63)$ or $\lg y=1.358x^2+0.31..$(or 0.32..)	M1	For correctly finding required equation(s)
	$b=1.36$, $\frac{163}{120}$ or $1\frac{43}{120}$	B1	Must be b = and from correct working
	A in range 2.05 to 2.09	A1	
6(b)	$\lg y=0.3132+(4\times1.36)$ $y=2.09\times10^{4\times1.36}$	M1	For $\lg y=(\textit{their } \lg A)+4(\textit{their } b)$ or $y=(\textit{their } A)\left(10^{4(\textit{their } b)}\right)$
	Allow 553 000 to 576 000	A1	
6 (c)	$4=2.09\left(10^{1.36x^2}\right)$ or $\lg4=0.3132+1.36x^2$	M1	$4=(\textit{their } A)\left(10^{\textit{their } bx^2}\right)$ or $\lg4=(\textit{their } \lg A)+(\textit{their } b)x^2$
	awrt 0.46	A1	

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7(a)	$-4a+b+5=0$ oe	**B1**	Allow multiples of equation
	$a+b-25=0$ oe	**B1**	Allow multiples of equation
	$a=6,\ b=19$	**2**	**M1** for solving *their* 2 equations and obtaining two solutions **A1** for both $a=6,\ b=19$
	$(x+4)(6x^2-5x+1)$ $A=6,\ B=-5,\ C=1$	**2**	**M1** for attempt to obtain quadratic factor by inspection or by algebraic long division **A1** $(6x^2-5x+1)$ or $A=6,\ B=-5,\ C=1$
	Alternative $a+b-25=0$ oe	**(B1)**	Allow multiples of equation
	Comparing coefficients $C=1$ and $A=a$	**(B1)**	
	$4A+B=b$	**(B1)**	
	Leading to $5A+B=25$	**(M1)**	For use of *their* $a+b-25=0$ to obtain an equation in A and B
	$4B+1=-19$	**(B1)**	
	$(x+4)(6x^2-5x+1)$ $A=6,\ B=-5,\ C=1$	**(A1)**	
7(b)	$(x+4)(3x-1)(2x-1)$	**B1**	Must follow from a correct solution to **(a)**
7(c)	–19	**B1**	
8(a)	$\angle AOB=1.45$ (radians)	**B1**	
8(b)	Sector area $=\frac{1}{2}(r^2)(1.45)$	**B1**	For correct sector area. Allow unsimplified
	Area of triangle $=\frac{1}{2}\times 0.5r\times r\times\sin(\pi-$ *their* $1.45)$	**B1**	For correct area of triangle Allow unsimplified
	Total area = $0.973r^2$	**B1**	

Question	Answer	Marks	Guidance
8(c)	$(AC^2) = r^2 + 0.25r^2 - (2 \times r \times 0.5r\cos(\pi - 1.45))$	**M1**	For correct substitution in cosine rule using $(\pi -$ *their* $1.45)$
	$AC = 1.17r$	**A1**	
	Perimeter = $2.95r + 1.17r$	**B1**	**FT** on *their* AC
	$r = 2.91$	**A1**	
9(a)	$\overrightarrow{AB} = \mathbf{b} - \mathbf{a}$ or $\overrightarrow{BA} = \mathbf{a} - \mathbf{b}$	**B1**	
	$\overrightarrow{OX} = \mathbf{a} + \frac{3}{4}\overrightarrow{AB}$ or $\overrightarrow{OX} = \mathbf{b} + \frac{1}{4}\overrightarrow{BA}$ $\overrightarrow{OX} = \mathbf{a} + \frac{3}{4}(\mathbf{b} - \mathbf{a})$ or $\overrightarrow{OX} = \mathbf{b} + \frac{1}{4}(\mathbf{a} - \mathbf{b})$	**M1**	For correct use of ratio, using *their* $\overrightarrow{AB}$ or $\overrightarrow{BA}$
	$\overrightarrow{OX} = \frac{\mathbf{a}}{4} + \frac{3}{4}\mathbf{b}$	**A1**	
9(b)	$\overrightarrow{AC} = 2\mathbf{b} - \mathbf{a}$	**B1**	
9(c)	$\overrightarrow{AY} = -\mathbf{a} + h\left(\frac{\mathbf{a}}{4} + \frac{3}{4}\mathbf{b}\right)$	**B1**	**FT** on *their* $\overrightarrow{OX}$
9(d)	$-\mathbf{a} + h\left(\frac{\mathbf{a}}{4} + \frac{3}{4}\mathbf{b}\right) = m(2\mathbf{b} - \mathbf{a})$	**M1**	For equating appropriate vectors and attempt to equate like vectors
	$-1 + \frac{h}{4} = -m$	**A1**	**FT** from *their* $\overrightarrow{AY}$ and $\overrightarrow{AC}$
	$\frac{3h}{4} = 2m$	**A1**	**FT** from *their* $\overrightarrow{AY}$ and $\overrightarrow{AC}$
	$h = \frac{8}{5},\ m = \frac{3}{5}$	**A1**	For both
10(a)	$\frac{3x + 10 + 2(x+1)}{(x+1)(3x+10)} = \frac{3x + 10 + 2x + 2}{(x+1)(3x+10)}$ $= \frac{5x + 12}{3x^2 + 13x + 10}$	**B1**	For expansion and simplification to obtain given answer

Question	Answer	Marks	Guidance
10(b)	$P\left(0,\ \frac{6}{5}\right)$ and $Q\left(-\frac{6}{5},\ 0\right)$ oe	**B1**	
	Area of triangle = $\frac{18}{25}$ or 0.72	**B1**	
	Area under curve = $\int_0^2 \frac{1}{x+1}+\frac{2}{3x+10}\ \mathrm{d}x$	**M1**	For use of part **(a)** and attempt to integrate to obtain at least one ln term.
	$=\left[\ln(x+1)+\frac{2}{3}\ln(3x+10)\right]_0^2$	**2**	**B1** For $\ln(x+1)$ **B1** For $\frac{2}{3}\ln(3x+10)$
	$=\ln 3+\frac{2}{3}\ln 16-\frac{2}{3}\ln 10$	**M1**	For correct use of limits. Dep on previous M mark.
	$=\frac{2}{3}\ln 3\sqrt{3}+\frac{2}{3}\ln 16-\frac{2}{3}\ln 10$	**M1**	For use of $\ln 3=\frac{2}{3}\ln 3\sqrt{3}$
	$=\frac{2}{3}\ln 3\sqrt{3}+\frac{2}{3}\ln\left(\frac{16}{10}\right)=\frac{2}{3}\ln\left(\frac{48\sqrt{3}}{10}\right)$	**M1**	For use of multiplication and division rule
	Total area = $\frac{18}{25}+\frac{2}{3}\ln\left(\frac{24\sqrt{3}}{5}\right)$ oe	**A1**	For correct answer in the required form dep on the three preceding M marks Must not be obtained using a calculator
11(a)	$2\cos x=3\frac{\sin x}{\cos x}\ \Rightarrow 2\cos^2 x=3\sin x$	**M1**	For use of $\tan x=\frac{\sin x}{\cos x}$ and multiplying by $\cos x$
	$2\left(1-\sin^2 x\right)=3\sin x$	**M1**	For use of correct identity
	$2\sin^2 x+3\sin x-2=0$	**A1**	For correct rearrangement to obtain the given answer
	Alternative $2\sin^2 x+3\sin x-2$ $=2\left(1-\cos^2 x\right)+3\sin x-2$	**(M1)**	For use of correct identity
	$=-2\cos x\cos x+3\sin x$ $=-3\tan x\cos x+3\sin x$	**(M1)**	For use of $2\cos x=3\tan x$
	$-3\sin x+3\sin x=0$	**(A1)**	For use of $\tan x\cos x=\sin x$ and answer 0

Question	Answer	Marks	Guidance
11(b)	$\sin\left(2\alpha+\frac{\pi}{4}\right)=\frac{1}{2}$ only	**B1**	For solution of quadratic from **(a)** to obtain $\sin\left(2\alpha+\frac{\pi}{4}\right)=\frac{1}{2}$ only
	$2\alpha+\frac{\pi}{4}=\frac{\pi}{6},\ \frac{5\pi}{6},\ \frac{13\pi}{6}$ $2\alpha=\frac{7\pi}{12},\ \frac{23\pi}{12}$	**M1**	For correct order of operations in attempt to solve $\sin\left(2\alpha+\frac{\pi}{4}\right)=\frac{1}{2}$, may be implied by one correct solution
	$\alpha=\frac{7\pi}{24}$	**A1**	
	$\alpha=\frac{23\pi}{24}$	**A1**	