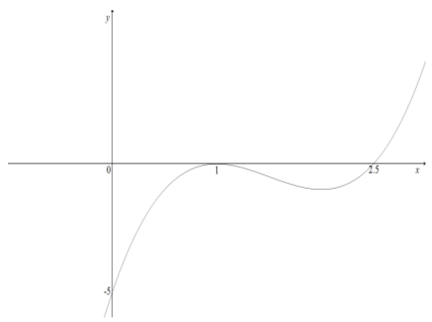
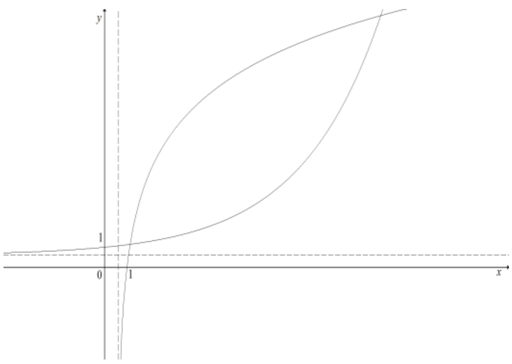
Question	Answer	Marks	Guidance
1(a)	$b = 3$	**B1**	
	Use of $y = a\cos bx + c$, with *their* b and either set of given coordinates	**M1**	*their* $b \neq \frac{2\pi}{3}$
	$c = -2$	**A1**	
	$a = 5$	**A1**	
1(b)	Minimum when $\cos bx = -1$ soi	**B1**	Allow for *their b*, $b \neq \frac{2\pi}{3}$
	$x = \frac{\pi}{3}$	**B1**	Allow if b is correct
	$y = -7$	**B1**	**FT** on *their c – their a*
	Alternative		
	$\frac{dy}{dx} = -15\sin 3x$	**(B1)**	**FT** on *their a, b* and *c*, $b \neq \frac{2\pi}{3}$
	When $\frac{dy}{dx} = 0$, $x = \frac{\pi}{3}$	**(B1)**	Allow if b is correct
	$y = -7$	**(B1)**	**FT** on *their c – their a*
2(a)	$(f'(x)) = 2(x-1)(2x-5) + 2(x-1)^2$ oe or $6x^2 - 18x + 12$	**M1**	For use of product rule or expansion and differentiation
	$2(x+1)(2x-5) + 2(x-1)^2 = 0$ oe or $6x^2 - 18x + 12 = 0$ oe	**M1**	**Dep** for equating *their* quadratic $f'(x)$ to zero and attempt to solve to obtain $x = \ldots$
	$x = 1, y = 0$ $x = 2, y = -1$	**2**	**A1** for any correct pair, must be from correct working only
2(b)		**3**	**B1** for a correct cubic shape **B1** for a correct cubic shape in the correct position, touching the x-axis once in the 4th quadrant and intersecting once with the positive x-axis **B1** for all intercepts and no extras
2(c)	$k < -1$	**B1**	
	$k > 0$	**B1**	

Question	Answer	Marks	Guidance
3(a)	$ACB = 2\tan^{-1}\left(\frac{12}{5}\right)$ oe	**M1**	
	$ACB = (2 \times 1.176\ldots)$ = 2.35 to 2 dp	**A1**	Must see justification to 2 dp
3(b)	Arc length = $5 \times ACB$	**B1**	
	Perimeter = 35.8	**B1**	Allow awrt 35.8
3(c)	Area = $(12 \times 5) - \left(\frac{1}{2} \times 5^2 \times 2.35\right)$	**M2**	**M1** for area of kite or area of sector **M1 dep** for kite area – sector area
	30.6	**A1**	Allow greater accuracy Any use of fractions gets **A0**
4(a)(i)	$\frac{2}{3}$	**B1**	Allow $x > \frac{2}{3}$, $a = \frac{2}{3}$, but not $x = \frac{2}{3}$ unless it is replaced with a correct answer
4(a)(ii)	$\mathbb{R}$ oe	**B1**	Must be using correct notation
4(a)(iii)	$3y - 2 = e^{\frac{x}{4}}$ or $3x - 2 = e^{\frac{y}{4}}$	**M1**	For valid attempt to reach this stage
	$f^{-1}(x) = \frac{1}{3}\left(e^{\frac{x}{4}} + 2\right)$	**A1**	Must be using correct notation
	Domain $x \in \mathbb{R}$ Range $f^{-1} > \frac{2}{3}$	**B2**	**B1** for each, must be using the correct notation.
4(a)(iv)		**4**	**B1** for the shape of $y = f(x)$ in the first and fourth quadrants only **B1 dep** on previous **B1** for (1, 0) **B1** for a correct shape for $f^{-1}(x)$, or **FT** on *their* $y = f(x)$ with correct shape in first quadrant for symmetry about $y = x$ soi **B1 dep** on previous **B1**, for (0, 1) and at least one point of intersection with $y = f(x)$ correct in the first quadrant

Question	Answer	Marks	Guidance
4(b)	$\left(2\left((2x+1)^{\frac{1}{2}}+4\right)+1\right)^{\frac{1}{2}}+4$	**B1**	
	$(2x+1)^{\frac{1}{2}}=8$	**B1**	**Dep**
	$x=31.5$ oe	**B1**	**Dep** on both previous **B** marks
	Alternative		
	$\mathrm{g}(x)=9$, $x=12$	**(B1)**	
	$\mathrm{g}(x)=12$	**(B1)**	**Dep**
	$x=31.5$ oe	**(B1)**	**Dep** on both previous **B** marks
5(a)	$\frac{\operatorname{cosec}^2\theta}{\cot^2\theta}=\frac{1}{\sin^2\theta}\times\frac{\sin^2\theta}{\cos^2\theta}$ $=\frac{1}{\cos^2\theta}=\sec^2\theta$	**B1**	Sufficient detail is needed Do not award if θ is consistently omitted
	Alternative 1		
	$\dfrac{\frac{\sin^2\theta+\cos^2\theta}{\sin^2\theta}}{\frac{\cos^2\theta}{\sin^2\theta}}$ $=\frac{1}{\cos^2\theta}=\sec^2\theta$	**(B1)**	Sufficient detail is needed Do not award if θ is consistently omitted
	Alternative 2		
	$\frac{1}{\cot^2\theta}+1$ $\tan^2\theta+1$	**(B1)**	Sufficient detail is needed Do not award if θ is consistently omitted
5(b)	$\sec^2\theta$	**B1**	
5(c)	$\int\left(\sec^2\theta-\sin\theta\right)\mathrm{d}\theta$ soi	**B1**	
	$\tan\theta+\cos\theta$	**B2**	**B1** for each
	$\sqrt{3}-\frac{1}{2}$ or exact equivalent	**B1**	**Dep** on 3 previous **B** marks
6(a)	$x^{10}+20x^7+180x^4$	**3**	**B1** for each correct term

Question	Answer	Marks	Guidance
6(b)	${}^8C_4\left(4x^2\right)^4\left(\frac{1}{2x^2}\right)^4$	M1	May be implied by working to obtain $r = 4$
	1120	A1	From correct working
7	$\left(\frac{dy}{dx}=\right)\frac{(x+2)\left(\frac{6x}{3x^2-1}\right)-\ln\left(3x^2-1\right)}{(x+2)^2}$ or $\frac{6x}{\left(3x^2-1\right)}(x+2)^{-1}-(x+2)^{-2}\ln\left(3x^2-1\right)$ oe	3	**B1** for $\frac{6x}{3x^2-1}$ **M1** for correct attempt at differentiation of a quotient or a correct product **A1** for all terms apart from $\frac{6x}{3x^2-1}$ correct.
	When $x = 1$, $\frac{dy}{dx}=\frac{9-\ln 2}{9}$	M1	For use of $x = 1$ in *their* $\frac{dy}{dx}$, must see a substitution if in decimal form unless 0.923 obtained from a correct derivative
	$\frac{dx}{dt}=\frac{9h}{9-\ln 2}$ or exact equivalent	2	**M1** for $\frac{h}{their\left(\frac{9-\ln 2}{9}\right)}$, with $x = 1$ substituted in **A0** if using small changes
8	$\frac{dy}{dx}=e^x k(2x+5)^{-\frac{1}{2}}+e^x(2x+5)^{\frac{1}{2}}$	M1	
	$\frac{dy}{dx}=e^x(2x+5)^{-\frac{1}{2}}+e^x(2x+5)^{\frac{1}{2}}$	A1	
	When $x = 2$, $\frac{dy}{dx}=\frac{10e^2}{3}$	M1	**Dep** allow unsimplified Allow for using *their* $\frac{dy}{dx}$
	When $x = 2$, $y = 3e^2$	B1	
	Tangent: $y-3e^2=\frac{10e^2}{3}(x-2)$	M1	Allow for using *their* $\frac{dy}{dx}$ and *their* y
	When $y = 0$, $x=\frac{11}{10}$	A1	Must be simplified Must be from correct work
	When $x = 0$, $y=-\frac{11e^2}{3}$	A1	
	$\left(\frac{11}{20},-\frac{11e^2}{6}\right)$	A1	**FT** on *their* coordinates for x and y, but must be exact and simplified

Question	Answer	Marks	Guidance
9	$\frac{8}{2x+1}=6x+1$ $12x^2+8x-7=0$	**M1**	Attempt to obtain a 3-term quadratic in one variable equated to zero.
	$x=\frac{1}{2}$	**2**	**M1 dep** for solution, see guidance
	$k\ln(2x+1)$	**M1**	
	Area under curve = $\left[k\ln(2x+1)\right]_0^{their\frac{1}{2}}$ = $k\ln(2(\textit{their } x)+1)\ (-0)$	**M1**	**Dep** on previous **M1** for correct application of limits using *their x, k* and zero Allow unsimplified
	Area under curve = 2ln 2	**A1**	Not from incorrect work
	Area under straight line = $\frac{5}{8}$ or 0.625 oe	**B1**	
	Shaded area = ln4 – $\frac{5}{8}$	**A1**	Not from incorrect work

Question	Answer	Marks	Guidance
9	**Alternative**		
	Either $\frac{8}{2x+1}=6x+1$ $12x^2+8x-7=0$	**(M1)**	Attempt to obtain a 3-term quadratic in one variable equated to zero.
	$x=\frac{1}{2}$	**(2)**	**M1 dep** for solution, see guidance
	$y=2$	**(A1)**	Award only if attempt at integration with respect to y is subsequently seen
	Or $x=\frac{2}{y}-\frac{1}{2}$ and $x=\frac{2y-1}{6}$ oe	**(M1)**	For rearranging both equations to obtain x or $2x$ in terms of y
	$2y^2+2y-12=0$	**(M1)**	**Dep** for attempt to obtain a 3-term quadratic in one variable equated to zero.
	$y=2$	**(2)**	**M1 dep** for solution, see guidance
	Then area enclosed between curve, y-axis and the line $y=2$ = $\left[k\ln y-\frac{1}{2}y\right]_{their\ 2}^{4}$ $=k\ln 4-2-k\ln 2+1$	**(M1)**	For correct application of limits using *their* $y = 2$, k and 4 Allow unsimplified
	$2\ln2 - 1$	**(A1)**	Not from incorrect work
	Area enclosed by straight line, the y axis and the line $y=2$, $=\frac{3}{8}$	**(B1)**	
	Shaded area = $\ln4-\frac{5}{8}$	**(A1)**	Not from incorrect work
10(a)	$\frac{30}{2}(4\tan 2x+(29\times 3\tan 2x))=455\sqrt{3}$	**M1**	For attempt to use sum formula with correct a and d
	$\tan 2x=\frac{\sqrt{3}}{3},\frac{455\sqrt{3}}{1365}$	**A1**	
	$x=-165°, -75°, 15°, 105°$	**3**	**M1** for 1 correct solution (allow if in radians or from use of $\tan 2x = 0.577$ or $\tan 2x = 0.58$ e.g. 14.99°, 15.06°.) **A1** for a second correct solution **A1** for 2 further correct solutions and no extras in the range

Question	Answer	Marks	Guidance
10(b)	$r = 4\cos^2\left(\theta - \frac{\pi}{2}\right)$	**B1**	
	$4\cos^2\left(\theta - \frac{\pi}{2}\right) < 1$ or $-1 < 4\cos^2\left(\theta - \frac{\pi}{2}\right) < 1$ or $0 \leqslant 4\cos^2\left(\theta - \frac{\pi}{2}\right) < 1$	**M1**	For use of sum to infinity condition
	$\theta = -\frac{\pi}{6}, \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}$	**2**	**M1 dep** for one correct critical value **A1** for all critical values and no extras in the range $-\frac{\pi}{6} \leqslant \theta \leqslant \frac{7\pi}{6}$
	$-\frac{\pi}{6} < \theta < \frac{\pi}{6}$ (excluding 0) $\frac{5\pi}{6} < \theta < \frac{7\pi}{6}$ (excluding π)	**2**	**A1** for each correct set of values