Question number	Scheme	Marks
10 (a)	$\frac{1}{2}+\sin 3x=0\Rightarrow \sin 3x=-\frac{1}{2}\Rightarrow 3x=-\frac{\pi}{6},\frac{7\pi}{6},\frac{11\pi}{6}\Rightarrow x=\frac{7\pi}{18},\frac{11\pi}{18}$	M1
	Coordinates of M are $\left(\frac{7\pi}{18},\ 0\right)$*	A1
	Coordinates of N are $\left(\frac{11\pi}{18},\ 0\right)$	A1 [3]
	ALT	
	$\frac{1}{2}+\sin\left(3\times\frac{7\pi}{18}\right)=0$	[M1
	Coordinates of M are $\left(\frac{7\pi}{18},0\right)$ *	A1
	Coordinates of N are $\left(\frac{11\pi}{18},0\right)$	A1]
(b)	$\frac{\mathrm{d}y}{\mathrm{d}x}=3\cos 3x=0\Rightarrow 3x=\frac{\pi}{2}\Rightarrow x=\frac{\pi}{6}$	M1A1
	$y=\frac{1}{2}+\sin 3\left('\frac{\pi}{6}'\right)=1.5$	dM1A1 [4]
	$\left[\text{Coordinates of point } A \text{ are } \left(\frac{\pi}{6},\ 1.5\right)\right]$	
	ALT	
	Max of sine curve is 1 so that $\frac{1}{2}+1=\frac{3}{2}\Rightarrow y=\frac{3}{2}$	[M1A1
	$\sin 3\theta=1 \ \Rightarrow\ 3\theta=\frac{\pi}{2}\ \Rightarrow\ \theta=\frac{\pi}{6}$	dM1A1]
	$\left[\text{Coordinates of point } A \text{ are } \left(\frac{\pi}{6},\ \frac{3}{2}\right)\right]$	
(c)	Uses the given x coordinate for point M	
	At point M $\quad \frac{\mathrm{d}y}{\mathrm{d}x}=3\cos\left(3\times\frac{7\pi}{18}\right)=-\frac{3\sqrt{3}}{2}$	B1
	$y-0=-\frac{3\sqrt{3}}{2}\left(x-\frac{7\pi}{18}\right)\Rightarrow 12y+18\sqrt{3}x-7\sqrt{3}\pi=0$ o.e.	M1A1A1 [4]
(d)	$A=\int_{0}^{\frac{7\pi}{18}}\left(\frac{1}{2}+\sin 3x\right)\,\mathrm{d}x+\left\|\left[\int_{\frac{7\pi}{18}}^{'\frac{11\pi}{18}'}\left(\frac{1}{2}+\sin 3x\right)\,\mathrm{d}x\right]\right\|$	M1
	$A=\left[\frac{1}{2}x-\frac{\cos 3x}{3}\right]_{0}^{\frac{7\pi}{18}}+\left\|\left[\frac{1}{2}x-\frac{\cos 3x}{3}\right]\right\|_{\frac{7\pi}{18}}^{'\frac{11\pi}{18}'}$	M1
	$A=\left[\left(\frac{1}{2}\times\frac{7\pi}{18}-\frac{\cos 3\left(\frac{7\pi}{18}\right)}{3}\right)-\left(0-\frac{\cos 3\times 0}{3}\right)\right]$	
		M1

	$+\left\lvert\left[\left(\frac{1}{2}\times\frac{11\pi}{18}-\frac{cos\,3\left(\frac{'11\pi'}{18}\right)}{3}\right)-\left(\frac{1}{2}\times\frac{7\pi}{18}-\frac{cos\,3\left(\frac{7\pi}{18}\right)}{3}\right)\right]\right\rvert$ $A=[(1.23287)+(0.22828)]=1.46115\ldots\approx 1.46$	A1 [4]
		Total 15 marks

Part	Mark	Notes
(a)	**M1**	Sets the equation equal to 0, solves using inverse sin and obtains a correct angle $\frac{1}{2}+\sin 3x=0\ \Rightarrow\ \sin 3x=-\frac{1}{2}\ \ \Rightarrow\ \ 3x=-\frac{\pi}{6}$ Condone working in degrees for M mark.
	A1 **cso**	For correctly obtaining $\left(\frac{7\pi}{18},0\right)$ * with no errors. Award for finding $\frac{7\pi}{18}$ and $\frac{11\pi}{18}$ but not shown as coordinates.
	A1	For correct coordinates of N: $\left(\frac{11\pi}{18},0\right)$
Alternative method		
	M1	For correct substitution of $\frac{7\pi}{18}$ into $\frac{1}{2}+\sin 3x$
	A1 **cso**	For correctly showing that $\frac{1}{2}+\sin\left(3\times\frac{7\pi}{18}\right)=0$ and stating $\left(\frac{7\pi}{18},0\right)$ * Award for showing $\frac{7\pi}{18}$ and finding $\frac{11\pi}{18}$ but not shown as coordinates
	A1	For correct coordinates of N: $\left(\frac{11\pi}{18},0\right)$
(b)	**M1**	For attempt to differentiate $y=\frac{1}{2}+\sin 3x$, set equal to 0 and solve for *x*. $\frac{\mathrm{d}y}{\mathrm{d}x}=3\cos 3x=0\ \Rightarrow\ 3x=\frac{\pi}{2}\ \ \Rightarrow\ \ x=\frac{\pi}{6}$ Condone finding *x* in degrees for this mark. Attempt at differentiation of two terms: $\frac{1}{2}\rightarrow 0$ $\sin(3x)\rightarrow k\cos(3x)$
	A1	For correctly obtaining $x=\frac{\pi}{6}$ **Note: Do not award this mark if $\frac{\mathrm{d}y}{\mathrm{d}x}$ is incorrect.**
	dM1	Substitutes $x=\frac{\pi}{6}$ to find a value for *y*. $y=\frac{1}{2}+\sin 3\left('\frac{\pi}{6}'\right)=1.5$ Condone working with *x* in degrees for this mark.
	A1	For correct coordinates of *A*. $\left(\frac{\pi}{6},\frac{3}{2}\right)$ Allow values equivalent to $\frac{3}{2}$
Alternative method		
	M1	For stating that the maximum of a sine curve is 1 and adding $\frac{1}{2}$
	A1	For correctly obtaining $y=\frac{3}{2}$
	dM1	For setting $\sin 3x$ equal to 1 and attempt to solve for *x* $\sin 3x=1\ \ \Rightarrow\ 3x=\frac{\pi}{2}\ \Rightarrow\ \ x=\frac{\pi}{6}$ Condone working with *x* in degrees for this mark.

	A1	For correctly obtaining $x = \frac{\pi}{6}$
(c)	**B1**	For correct gradient at point *M* $\left(\frac{\mathrm{d}y}{\mathrm{d}x}\right) = -\frac{3\sqrt{3}}{2}$
	M1	For a fully correct method of finding the equation of the tangent to *C* at *M* $y - 0 = {}' - \frac{3\sqrt{3}}{2}{}'\left(x - \frac{7\pi}{18}\right)$ Allow use of their $-\frac{3\sqrt{3}}{2}$ obtained from substitution of $x = \frac{7\pi}{18}$ into their $\frac{\mathrm{d}y}{\mathrm{d}x}$.
	A1	For a correct equation of the tangent in any form: $y - 0 = -\frac{3\sqrt{3}}{2}\left(x - \frac{7\pi}{18}\right)$
	A1	For correct equation of the tangent in the required form: $12y + 18\sqrt{3}x - 7\sqrt{3}\pi = 0$ Accept integer multiples of this equation.
(d)	**M1**	For identifying the correct limits to find the area above the curve and the area below the curve: $\int_0^{\frac{7\pi}{18}}\left(\frac{1}{2} + \sin 3x\right) + \left\|\int_{\frac{7\pi}{18}}^{\frac{11\pi}{18}}\left(\frac{1}{2} + \sin 3x\right)\right\|$ or $\int_0^{\frac{7\pi}{18}}\left(\frac{1}{2} + \sin 3x\right) - \int_{\frac{7\pi}{18}}^{\frac{11\pi}{18}}\left(\frac{1}{2} + \sin 3x\right)$ Allow use of their $\frac{11\pi}{18}$. Needs to correctly indicate dealing with areas above and below axis.
	M1	For an attempt to integrate $\frac{1}{2} + \sin 3x$ obtaining: $\frac{1}{2}x - k\cos 3x \quad \text{where } k \neq -3$ For this mark ignore incorrect / absent limits.
	M1	For substituting limits correctly into their integrated expression (must be a changed expression). $A = \left[\left(\frac{1}{2} \times \frac{7\pi}{18} - \frac{cos\,3\left(\frac{7\pi}{18}\right)}{3}\right) - \left(0 - \frac{cos\,3 \times 0}{3}\right)\right] + \left\|\left[\left(\frac{1}{2} \times \frac{11\pi}{18} - \frac{cos\,3\left(\frac{{}'11\pi{}'}{18}\right)}{3}\right) - \left(\frac{1}{2} \times \frac{7\pi}{18} - \frac{cos\,3\left(\frac{7\pi}{18}\right)}{3}\right)\right]\right\|$ Allow use of their $\frac{11\pi}{18}$. Must show substitution or M0.
	A1	For correctly obtaining awrt 1.46

Question number	Scheme	Marks
11 (a)	$\mathrm{f}(x)=\int ax^2-14x-10\ \mathrm{d}x=\frac{ax^3}{3}-\frac{14x^2}{2}-10x+c$	M1A1
	$\mathrm{f}(4)=\frac{a\times4^3}{3}-\frac{14\times4^2}{2}-10\times4+c=0\Rightarrow\frac{64a}{3}-152+c=0$	M1
	$\mathrm{f}(-1)=\frac{a\times(-1)^3}{3}-\frac{14\times(-1)^2}{2}-10\times(-1)+c=25\Rightarrow-\frac{a}{3}-22+c=0$	M1
	$\frac{64a}{3}-152+c=0$ $-\frac{a}{3}-22+c=0$ $\Rightarrow152-\frac{64a}{3}=22+\frac{a}{3}\Rightarrow a=6$	M1A1 [6]
(b)	$c=22+\frac{6}{3}=24$	B1
	$\mathrm{f}(x)=2x^3-7x^2-10x+24$ $x-4\overline{\big)2x^3-7x^2-10x+24}$ with quotient $2x^2+x-6$	M1A1
	$\mathrm{f}(x)=(x-4)(2x-3)(x+2)=0$	dM1A1
	$x=4,\ \frac{3}{2},\ -2$	A1 [6]
	ALT $2x^3-7x^2-10x+24=(x-4)(ax^2+bx+c)$ $a=2,b=1,c=-6$	[M1
	$f(x)=(x-4)(2x^2+x-6)$	A1
	$f(x)=(x-4)(2x-3)(x+2)=0$	dM1A1
	$x=4,\frac{3}{2},-2$	A1]
		Total 12 marks

Part	Mark	Notes
(a)	**M1**	For an attempt to integrate $\mathrm{f}'(x)=ax^2-14x-10$ See General Guidance on what constitutes an attempt to integrate.
	A1	For correctly integrating $\mathrm{f}'(x)$ to obtain $\mathrm{f}(x)=\frac{ax^3}{3}-\frac{14x^2}{2}-10x+c$ Must include $+c$ for this mark.
	M1	For substituting $x=\pm4$ in their $\mathrm{f}(x)$ and setting =0
	M1	For substituting $x=\pm1$ in their $\mathrm{f}(x)$ and setting =25

	M1	For correct method to solve the equations simultaneously to find a A correct intermediate step is required e.g. $65a = 390$
	A1 cso	For fully correct working leading to $a = 6$
(b)	**B1**	For correctly identifying $c = 24$
	M1	For attempt to divide f(x) by $x - 4$ Must get as far as $2x^2 + \cdots$
	A1	For correct division of f(x) by $x - 4$ to obtain $2x^2 + x - 6$
	dM1	For an attempt to factorise their 3TQ which must come from a cubic. See General Guidance on what constitutes an attempt to factorise.
	A1	For obtaining correct factorisation of the cubic: $(x-4)(2x-3)(x+2)$
	A1	For all three correct solutions of the equation: $x = 4, \frac{3}{2}, -2$
Alternative method		
	M1	For an attempt to find the quadratic factor that multiplies $x - 4$ to give f(x) Must get as far as $f(x) = (x-4)(2x^2 + bx + c)$
	A1	For correctly comparing coefficients to obtain $2x^2 + x - 6$
	dM1	For an attempt to factorise their 3TQ which must come from a cubic. See General Guidance on what constitutes an attempt to factorise.
	A1	For obtaining correct factorisation of the cubic: $(x-4)(2x-3)(x+2)$
	A1	For all three correct solutions of the equation: $x = 4, \frac{3}{2}, -2$
	Note: Correct solution seen with no working scores B0M0A0M0A0A0	

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