Q	Marking instructions	AO	Marks	Typical solution
15(a)	Uses small angle approximation for sine at least once.	1.1b	B1	$\sin x - \sin x \cos 2x \approx x - x\left(1-\frac{(2x)^2}{2}\right)$ $\approx x - x + x\frac{4x^2}{2}$ $\approx 2x^3$
	Replaces $\cos 2x$ with $1-\frac{(2x)^2}{2}$ Or Used double angle identity and small angle approximations Condone a sign error or missing brackets.	3.1a	M1	
	Completes rigorous argument to show the given result. Condone "=" instead of "$\approx$"	2.1	R1	
	Subtotal		**3**	

Q	Marking instructions	AO	Marks	Typical solution
15(b)	Forms an integral of the form $\int_0^{0.25} y\,\mathrm{d}x$ or better where y is their $\sqrt{8\times 2x^3}$. Condone missing limits and dx.	3.1a	M1	$Area \approx \int_0^{0.25} \sqrt{8\times 2x^3}\,\mathrm{d}x$ $= 4\int_0^{0.25} x^{3/2}\,\mathrm{d}x$ $= 4\left[\frac{2x^{5/2}}{5}\right]_0^{0.25}$ $= \frac{8}{5}\times 0.25^{5/2}$ $= \frac{8}{5}\times\left(\frac{1}{2}\right)^5$ $= 2^{-2}\times 5^{-1}$
	Simplifies integrand to $Bx^{3/2}$	1.1a	M1	
	Integrates their integrand of the form $Bx^{3/2}$ correctly	1.1b	A1F	
	Substitutes correct limits and completes argument to obtain correct approximation in correct form.	2.1	R1	
	Subtotal		**4**	

Q	Marking instructions	AO	Marks	Typical solution
15(c)(i)	Explains that the limits or 6.4 and 6.3 are not small.	2.4	E1	The approximation is only valid for small values of x and 6.3 and 6.4 are not small.
	Subtotal		**1**	

Q	Marking instructions	AO	Marks	Typical solution
15(c)(ii)	Explains how the limits can be changed. Examples of reasoning could include: $\sin x - \sin x \cos 2x$ is periodic OE (has a period of 2π PI) evaluating the integral over a different interval will result in the same value. Reduce/shift the limits by 2π The graph repeats Uses a substitution to bring the limits within an acceptable interval.	2.4	E1	$\sin x - \sin x \cos 2x$ repeats so evaluate the integral over a different interval. Use small values $a = 6.3 - 2\pi$ and $b = 6.4 - 2\pi$ to obtain a valid approximation.
	Deduces $a = 6.3 - 2\pi$ = AWRT 0.017 and $b = 6.4 - 2\pi$ = AWRT 0.117	2.2a	R1	
	Subtotal		**2**	

	Question Total		**10**	