

Question	Scheme	Marks	AOs
11	$f(x) = \frac{\sin 2x}{-3 + \cos 2x}, \quad 0 \leq x \leq \pi$		
(a)	$\left\{ \begin{array}{l} u = \sin 2x \quad v = -3 + \cos 2x \\ \frac{du}{dx} = 2 \cos 2x \quad \frac{dv}{dx} = -2 \sin 2x \end{array} \right\}$		
	$f'(x) = \frac{(-3 + \cos 2x)(2 \cos 2x) - (\sin 2x)(-2 \sin 2x)}{(-3 + \cos 2x)^2}$	M1	2.1
		A1	1.1b
	$f'(x) = 0 \Rightarrow (-3 + \cos 2x)(2 \cos 2x) - (\sin 2x)(-2 \sin 2x) = 0$	M1	1.1b
	$-6 \cos 2x + 2 \cos^2 2x + 2 \sin^2 2x = 0 \Rightarrow -6 \cos 2x + 2 = 0$ $\Rightarrow \cos 2x = \frac{1}{3} *$	A1*	2.1
(b)	Maximum turning point for (i) $y = f(3x) + 5$, (ii) $y = -f\left(\frac{1}{4}x\right)$		
	$\left\{ \cos 2x = \frac{1}{3} \Rightarrow \text{Principal Value} = 1.2309593... \right\}$		
	(i) For either <ul style="list-style-type: none"> • $\left\{ \cos 6x = \frac{1}{3} \text{ (2nd sol}^n \text{)} \Rightarrow \right\} x = \frac{2\pi - 1.2309593...}{6}$ • $\left\{ \cos 2x = \frac{1}{3} \text{ (2nd sol}^n \text{)} \Rightarrow \right\} 3x = \frac{2\pi - 1.2309593...}{2} \Rightarrow x = ...$ 	M1	3.1a
	$\Rightarrow x = 0.842037... = 0.84 \text{ (2 dp)}$	A1	1.1b
	(ii) For either <ul style="list-style-type: none"> • $\left\{ \cos\left(\frac{1}{2}x\right) = \frac{1}{3} \text{ (1st sol}^n \text{)} \Rightarrow \right\} x = 2(1.2309593...)$ • $\left\{ \cos 2x = \frac{1}{3} \text{ (2nd sol}^n \text{)} \Rightarrow \right\} \frac{1}{4}x = \frac{1.2309593...}{2} \Rightarrow x = ...$ 	M1	3.1a
	$\Rightarrow x = 2.461918... = 2.46 \text{ (2 dp)}$	A1	1.1b
		(4)	

(8 marks)

Question 11 Notes:**(a)**

M1: Attempts to differentiate by using the quotient rule with $u = \sin 2x$ and $v = -3 + \cos 2x$ or attempts to differentiate by using the product rule with $u = \sin 2x$ and $v = (-3 + \cos 2x)^{-1}$

A1: Correct $f'(x)$, which can be un-simplified or simplified

M1: Sets $f'(x) = 0$ and proceeds with their working to set the numerator of $f'(x)$ equal to 0

A1*: Shows $\cos 2x = \frac{1}{3}$ with no errors seen in their working

(b)(i)**M1:**

- Attempts to find the second solution for $\cos 6x = \frac{1}{3}$

E.g. $x = \frac{2\pi - 1.2309593\dots}{6} = \frac{5.052225\dots}{6}$

- Attempts to find the second solution of $\cos 2x = \frac{1}{3}$ and proceeds to divide their result by 3

E.g. $3x = \frac{2\pi - 1.2309593\dots}{2} \Rightarrow x = \frac{2.526112\dots}{3}$

A1: 0.84 (2 dp) or anything that rounds to 0.84

(b)(ii)**M1:**

- Attempts to find the first solution for $\cos\left(\frac{1}{2}x\right) = \frac{1}{3}$

E.g. $x = 2(1.2309593\dots)$

- Attempts to find the first solution of $\cos 2x = \frac{1}{3}$ and proceeds to multiply the result by 4

E.g. $\frac{1}{4}x = \frac{1.2309593\dots}{2} \Rightarrow x = 4(0.615479\dots)$

A1: 2.46 (2 dp) or anything that rounds to 2.46