Question Number	Scheme	Marks
4. (i) (a)	$f'(x)=\dfrac{4(x-3)(2x+5)-(2x+5)^2}{(x-3)^2}$ or $\dfrac{(x-3)(8x+20)-(4x^2+20x+25)}{(x-3)^2}$	M1 A1
	$=\dfrac{(2x+5)(2x-17)}{(x-3)^2}$	M1 A1
(b)	Attempts both critical values or finds one "correct" end	M1
	$x<-2.5,\ x>8.5$ (accept $x\leqslant -2.5,\ x\geqslant 8.5$)	A1
		(6)
(ii)	Attempts the chain rule on $(\sin 4x)^{\frac{1}{2}}\rightarrow A(\sin 4x)^{-\frac{1}{2}}\times\cos 4x$	M1
	$g(x)=x(\sin 4x)^{\frac{1}{2}}\Rightarrow g'(x)=(\sin 4x)^{\frac{1}{2}}+x\times\dfrac{1}{2}(\sin 4x)^{-\frac{1}{2}}4\cos 4x$	M1 A1
	Sets $g'(x)=0\rightarrow(\sin 4x)^{\frac{1}{2}}+x\times\dfrac{2\cos 4x}{(\sin 4x)^{\frac{1}{2}}}=0$ and $\times\dfrac{(\sin 4x)^{\frac{1}{2}}}{\cos 4x}$ oe	M1
	$\rightarrow\tan 4x+2x=0$	A1
		(5)
		11 marks

(i)(a)

M1 Attempts the quotient rule and achieves

$$f'(x)=\frac{A(x-3)(2x+5)-B(2x+5)^2}{(x-3)^2}\quad A,B>0 \text{ condoning slips}$$

Alternatively uses the product rule and achieves

$$\frac{d}{dx}\left\{(x-3)^{-1}(2x+5)^2\right\}=\pm A(2x+5)^2(x-3)^{-2}+B(x-3)^{-1}(2x+5)\quad A,B>0$$

They may attempt to multiply out the $(2x+5)^2$ first which is fine as long as they reach a 3TQ.

A1 Score for correct unsimplified $f'(x)$

M1 Attempts to take out a factor of $(2x+5)$ or multiplies out and attempts to factorise the numerator.

The method must be seen $\dfrac{(x-3)4(2x+5)\pm(2x+5)^2}{...}=\dfrac{(2x+5)\{(x-3)4\pm(2x+5)\}}{...}$ condoning slips.

If the method is not seen it may be implied by a correct result for their fraction

This can be achieved from an incorrect quotient or product rule. E.g. $\dfrac{vu'+uv'}{v^2}$ or $\dfrac{vu'-uv'}{v}$

It can be scored by candidates who multiply out their numerators and then factorise by taking out a factor of $(2x+5)$

If the product rule is used it would be for writing as a single fraction and taking out, from the numerator, a common factor of $(2x+5)$.

A1 $\dfrac{(2x+5)(2x-17)}{(x-3)^2}$ but accept expressions such as $\dfrac{4(x+2.5)(x-8.5)}{(x-3)^2}$ or $\dfrac{(2x+5)(2x-17)}{(x-3)(x-3)}$

Note the final two marks in (i)(a) may be scored in (i)(b), ONLY IF the correct work is done on the complete fraction, not just the numerator

(i)(b)

M1 Achieves the two critical values from the quadratic numerator of their $f'(x)$

Alternatively finds one correct end for their $(2x+5)(2x-17)>0$ or $(2x+5)(2x-17)\geqslant 0$

So award for either $x<-2.5$ or $x>$ their 8.5 which may be scored from an intermediate line.

A1 $x<-2.5, x>8.5$ (accept $x\leqslant -2.5,\ x\geqslant 8.5$).

Ignore any references to "and" or "or" so condone $x<-2.5$ and $x>8.5$

Mark the final response. This is not isw

It may follow working such as $(2x+5)(2x-17)>0 \Rightarrow x>-\frac{5}{2}, x>\frac{17}{2}$. So $x<-2.5, x>8.5$

Accept alternative forms such as $(-\infty,-2.5]\cup[8.5,\infty)$

(ii)

M1 Attempts the chain rule on $(\sin 4x)^{\frac{1}{2}} \rightarrow A(\sin 4x)^{-\frac{1}{2}}\times\cos 4x$

M1 For an attempt at the product rule.

If they state $u=x, v=(\sin 4x)^{\frac{1}{2}}, u'=1, v'=...$ award for $(\sin 4x)^{\frac{1}{2}}+x\times$ their v'

If this is not stated or implied by their $uv'+vu'$ then award for $(\sin 4x)^{\frac{1}{2}}+x\times(\sin 4x)^{-\frac{1}{2}}...$

A1 $(g'(x))=(\sin 4x)^{\frac{1}{2}}+2x(\sin 4x)^{-\frac{1}{2}}\cos 4x$ which may be unsimplified.

You may not see the lhs which is fine. Condone $\sin 4x^{\frac{1}{2}}$ for $(\sin 4x)^{\frac{1}{2}}$ if subsequent work is correct

M1 Sets their $g'(x)$ which must be of the form $(\sin 4x)^{\frac{1}{2}}+kx(\sin 4x)^{-\frac{1}{2}}\cos 4x$ equal to 0

and proceeds with correct work to an equation of the correct form. Allow $\tan 4x=kx$ here

A1 cso $\tan 4x+2x=0$

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Alt to (a) via division which may not be very common

M1 Score for $\frac{(2x+5)^2}{x-3}\rightarrow Ax+B+\frac{C}{x-3}$ differentiating to $A\pm\frac{C}{(x-3)^2}$

A1 $4-\frac{121}{(x-3)^2}$

M1 Forms a single fraction and attempts to factorise out $(2x+5)$ from the numerator (which must be a 3TQ)

A1 $\frac{(2x+5)(2x-17)}{(x-3)^2}$

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Alt to (b) via squaring

$$[g(x)]^2=x^2\sin 4x \Rightarrow 2g(x)g'(x)=2x\sin 4x+4x^2\cos 4x$$

M1 Correct form for the rhs. Apply the same rules as the main method. Condone slips on coefficients

dM1 Correct form for the left hand side as well as the right hand side. Condone a slip on the coefficient

A1 $2g(x)g'(x)=2x\sin 4x+4x^2\cos 4x$

ddM1 Sets $g'(x)=0$ and proceeds with correct work to an equation of the correct form.

A1 cso $\tan 4x+2x=0$

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Question Number	Scheme	Marks
5 (a)	$12\tan 2x + 5\cot x \sec^2 x = 0$	
	$12\times\dfrac{2t}{1-t^2} + 5\times\dfrac{1}{t}\left(1+t^2\right) = 0$	B1 M1 A1
	$12\times 2t^2 + 5\left(1+t^2\right)\left(1-t^2\right) = 0 \rightarrow 5t^4 - 24t^2 - 5 = 0$ *	A1*
		(4)
(b)	$5t^4 - 24t^2 - 5 = 0$	
	$\left(5t^2+1\right)\left(t^2-5\right) = 0$	M1
	Correct order of operations $t = (\pm)\sqrt{5} \Rightarrow x = ..$	dM1
	Two of awrt $x = 66°, 114°, 246°, 294°$	A1
	All four of awrt $x = 65.9°, 114.1°, 245.9°, 294.1°$	A1
		(4)
		8 marks

(a)

B1 Any **correct** identity used within the given equation either in terms of $\tan x$ or in terms of t

Eg: Attempts to replace either $\tan 2x = \dfrac{2\tan x}{1-\tan^2 x}$, $\cot x = \dfrac{1}{\tan x}$ or $\sec^2 x = 1 + t^2$

M1 Uses $\tan 2x = \dfrac{2\tan x}{1\pm\tan^2 x}$, $\cot x = \dfrac{1}{\tan x}$, and $\sec^2 x = \pm 1 \pm \tan^2 x$ or with $t = \tan x$ to produce an equation in terms of t or $\tan x$

A1 Correct intermediate equation in t or $\tan x$ The = 0 may be implied by later work

A1* For proceeding to the correct answer with a correct intermediate line. Must have = 0 .
There cannot be any notational or bracketing errors within the body of the solution if this mark is to be awarded. A notational error is $\tan x^2 \leftrightarrow \tan^2 x$
The intermediate line should be of a form in which the given answer could immediately follow. See main scheme for such an example; the fractional terms have been dealt with in this case.
Condone partially completed lines if the candidate is only working on one side of the equation

(b)

M1 Correct attempt to solve.

Allow an attempt to factorise $5t^4 - 24t^2 - 5 = 0 \Rightarrow \left(at^2 + b\right)\left(ct^2 + d\right) = 0$ with $ac = \pm 5, bd = \pm 5$

Alt lets $u = t^2$ and attempts to factorise $5u^2 - 24u - 5 = 0 \Rightarrow$ with usual rules.

Allow use of calculator giving $t^2 = 5$ or $\tan^2 x = 5$ (You may ignore the negative root).

It is also implied by $t = \sqrt{5}$ or $t = -\sqrt{5}$ Watch out for $\tan x = 5$ which is M0

dM1 For using the correct order of operations and finding one value of x for their $t^2 = k$ where k is a positive constant. Allow accuracy to either the nearest degree or correct to 1dp in radians.
It is dependent upon them having scored the previous M1.

A1 Any two of awrt $x = 66°, 114°, 246°, 294°$ May be implied by awrt two of 1.15, 1.99, 4.29, 5.13

A1 All four of awrt $x = 65.9°, 114.1°, 245.9°, 294.1°$ AND no extras within the range.