Question Number	Scheme	Marks
	$f(x) = 8\sin x\cos x + 4\cos^2 x - 3$	
4(a)	States or uses $\sin 2x = 2\sin x\cos x$ or $\cos 2x = \pm 2\cos^2 x \pm 1$	M1
	Uses $\sin 2x = 2\sin x\cos x$ and $\cos 2x = \pm 2\cos^2 x \pm 1$ in f (x)	dM1
	$\left(f(x) =\right) 8\sin x\cos x + 4\cos^2 x - 3 = 4\sin 2x + 2\cos 2x - 1$	A1
		(3)
(b)	$R^2 = a^2 + b^2 \Rightarrow R = \sqrt{20}$ or $2\sqrt{5}$	B1ft
	$\tan\alpha = \frac{b}{a} \Rightarrow \alpha = ...$ $\left(= \text{"awrt } 0.464\text{"}\right)$	M1
	$\left(f(x) =\right)\ 2\sqrt{5}\sin\left(2x + 0.464\right) - 1$	A1
		(3)
(c)	(i) Maximum value = $\text{"}2\sqrt{5} - 1\text{"}$	B1 ft
	(ii) Solves $2x + \alpha = \frac{5\pi}{2} \Rightarrow x = ...$	M1
	$\left(x =\right)$ awrt 3.69 (or $\left(x =\right)$ awrt 3.70)	A1
		(3)
		(9 marks)

(a) For the method marks condone working in mixed variables provided the intention is clear

M1: **Either** states one of the correct identities $\sin 2x = 2\sin x\cos x$ or $\cos 2x = 2\cos^2 x - 1$

or uses $\sin 2x = 2\sin x\cos x$ or $\cos 2x = \pm 2\cos^2 x \pm 1$ (may be implied by use of e.g. $\cos^2 x = \pm 1 \pm \sin^2 x$ and $\cos 2x = \pm 1 \pm 2\sin^2 x$ or $\cos 2x = \pm\cos^2 x \pm \sin^2 x$)

Can be implied by **either of**

- $a = 4$
- $b = \pm 2$ **and** $c = -5$ or -1

dM1: **Uses** $\sin 2x = 2\sin x\cos x$ and $\cos 2x = \pm 2\cos^2 x \pm 1$ (which may be implied as above for the first method mark) in f (x) to produce an expression of the required form $a\sin 2x + b\cos 2x + c$ Condone slips when substituting in.

Can be implied by $a = 4$ **and** $b = \pm 2$ **and** $c = -5$ or -1

A1: $4\sin 2x + 2\cos 2x - 1$ Correct answer scores all three marks. Must be in terms of x.

(b) **Full marks can only be scored provided correct values for *a*, *b* and *c* are found in (a).**

B1ft: Finds the exact value of R using $R^2 = a^2 + b^2$ (or may use trigonometry using their value for α)

Can be implied by a correct exact value.

Follow through on their a or b but the correct values should give $R = \sqrt{20}$ or $2\sqrt{5}$

M1: Uses a "correct " method to find α using their *a* and *b*. Accept for example $\tan\alpha = \pm\frac{b}{a} \Rightarrow \alpha = ...$ or $\tan\alpha = \pm\frac{a}{b} \Rightarrow \alpha = ...$ (You may need to check this on your calculator if only the angle is seen)

May also be seen using e.g. $\sin\alpha = \pm\frac{b}{"R"} \Rightarrow \alpha = ...$ or $\cos\alpha = \pm\frac{a}{"R"} \Rightarrow \alpha = ...$ Allow the angle to be found in degrees for this mark. $\alpha =$"awrt 26.6°" (1dp)

A1cso: $\left(f(x) =\right)\ 2\sqrt{5}\sin\left(2x + \text{awrt } 0.464\right) - 1$ o.e. e.g. $\left(f(x) =\right)\ \sqrt{20}\sin\left(2x + 0.464\right) - 1$ (may be awarded if seen in (c)) Can only be scored provided correct values for *a*, *b* and *c* are found in (a).

(c) (i)

B1ft: "$2\sqrt{5} - 1$" o.e. e.g. "$\sqrt{20} - 1$" but follow through on their $R + c$ as long **as *R* has been correctly found** (ie awarded in (b)). Ft on their *c* which may be different in (a) and (b) but **cannot be 0**

Allow to be a decimal if *R* was given as a decimal in (b) at any point. isw following a correct answer.

(c)(ii)

M1: Solves $2x + \alpha = \frac{5\pi}{2} \Rightarrow x = ...$ using their α found in (b) (note that this is still the equation which will need to be solved if they differentiate f(*x*) first and set equal to 0). You may need to check this on your calculator.

Allow this mark to be scored even if there are additional equations formed (and possibly solved).

They must be consistent in their use of degrees or radians in an equation that they are solving.

$\frac{5\pi}{2} = 7.85...$ may be used in their working.

A1: $\left(x =\right)$ awrt 3.69 but also allow $\left(x =\right)$ awrt 3.70 . If several angles are found then they must indicate which angle is their final answer by e.g. underlining, circling

Question Number	Scheme	Marks
5 (a)	$\mathrm{f}^{-1}(22) \Rightarrow 2+5\ln x = 22 \Rightarrow \ln x = 4 \Rightarrow (x=)\ \mathrm{e}^4$	M1 A1 **(2)**
(b)	$\mathrm{g}(x) = \dfrac{6x-2}{2x+1} \Rightarrow \mathrm{g}'(x) = \dfrac{6(2x+1)-2(6x-2)}{(2x+1)^2}$	M1 A1
	States $(\mathrm{g}'(x)=)\ \dfrac{10}{(2x+1)^2} > 0$ hence increasing *	A1* **(3)**
(c)	$y = \dfrac{6x-2}{2x+1} \Rightarrow 2xy + y = 6x - 2 \Rightarrow 2xy - 6x = -y - 2$	M1
	$\Rightarrow x = \dfrac{-y-2}{2y-6}$ So $\mathrm{g}^{-1}(x) = \dfrac{-x-2}{2x-6}$ o.e.	A1
	Domain $0 < x < 3$	B1 **(3)**
(d)	Range fg is $\mathrm{fg} < 2+5\ln 3$	M1, A1 **(2)**
		(10 marks)

(a)

M1: Sets $2+5\ln x = 22$ and rearranges to $\ln x = ...$ (may be implied by further work)

Alternatively, may attempt to find $\mathrm{f}^{-1}(x)$ and substitute 22 into the expression. i.e. $\mathrm{f}^{-1}(x) = \mathrm{e}^{\frac{\pm x \pm 2}{5}}$.
Maybe implied by awrt 55.
Condone sign slips only in their rearrangement.

A1: e^4 (must be simplified and exact) isw once a correct answer is seen.

(b)

M1: Either

- attempts to use the quotient rule proceeding to the form $\dfrac{A(2x+1)-B(6x-2)}{(2x+1)^2}$ o.e. where A and B are both positive. Do not award this mark if the quotient rule is applied the wrong way round.
- attempts to use the product rule proceeding to the form $(6x-2)(2x+1)^{-1} \Rightarrow \pm C(6x-2)(2x+1)^{-2} \pm D(2x+1)^{-1}$
- writes g(x) as $3-\dfrac{5}{2x+1} = 3-5(2x+1)^{-1}$ and attempts to use the chain rule proceeding to the form $E(2x+1)^{-2}$

In all methods invisible brackets can be recovered or implied by further work.

A1: Correct unsimplified e.g. $\dfrac{6(2x+1)-2(6x-2)}{(2x+1)^2}$ or $-2(6x-2)(2x+1)^{-2}+6(2x+1)^{-1}$ or $10(2x+1)^{-2}$