Question Number	Scheme	Marks
5 (a)	$\text{ff}(x)=\dfrac{2\times\left(\dfrac{2x+16}{x-4}\right)+16}{\left(\dfrac{2x+16}{x-4}\right)-4}, \dfrac{2\times(2x+16)+16(x-4)}{(2x+16)-4(x-4)}, =\dfrac{10x-16}{-x+16}$	M1, dM1, A1 **(3)**
(b)	$\dfrac{2x+16}{x-4}=12\Rightarrow 10x=64\Rightarrow x=6.4$	M1 A1 **(2)**
(c)	$\dfrac{2\ln a+16}{\ln a-4}=\ln a\Rightarrow(\ln a)^2-6\ln a-16=0$ $\Rightarrow(\ln a-8)(\ln a+2)=0\Rightarrow \ln a=8,-2$ $\Rightarrow a=\text{e}^{-2},\text{e}^{8}$	M1 dM1 A1 **(3)** **8 marks**

(a)

M1 Attempts to fully substitute f(x) for x in $\dfrac{2x+16}{x-4}$. Condone **one** slip as long as the intention is clear and there are two substitutions of f(x) for x.

dM1 Dependent on the first M1. Correct attempt to form a single fraction (see scheme) by multiplying two terms in the numerator and two terms in the denominator by $(x-4)$

A1 $\dfrac{10x-16}{-x+16}$ or exact simplified equivalent

(b)

M1 Attempts to solve $\text{f}(x)=12$ using correct order of operations (multiplying by $x-4$ and grouping terms in x).

Alternatively, reaches $\text{f}^{-1}(x)=\dfrac{ax+b}{cx+d}$ using correct order of operations and attempts to substitute $x=12$. Note: $\text{f}^{-1}(x)=\dfrac{4x+16}{x-2}$

A1 6.4 o.e.

(c) **Note:** If correct answers appear without a 3TQ, send to review.

M1 Sets up a 3TQ in $\ln a$. Must have three terms, but not necessarily on one side of the equation. Condone a four term quadratic with all terms on one side if it is followed by a correct attempt to solve. Condone missing "=0".

dM1 Dependent on the first M1. Full attempt to solve a 3TQ in $\ln a$, using any valid method (including calculator), reaching two values, which do not necessarily have to be labelled $\ln a$. Allow a substitution, e.g. $x=\ln a$ or even $a=\ln a$.

A1 $a=\text{e}^{8},\text{e}^{-2}$ (or $\dfrac{1}{\text{e}^{2}}$) and no others. Accept answers labelled as x or unlabelled. Apply isw (e.g. if exact answers are followed by decimals). Must follow M1 dM1.

Question Number	Scheme	Marks
6 (a)	$2\cos(\theta-60°)=3\sin\theta \Rightarrow 2\cos\theta\cos 60°+2\sin\theta\sin 60°=3\sin\theta$	M1, A1
	$\Rightarrow \cos\theta=\left(3-\sqrt{3}\right)\sin\theta$ or $\Rightarrow 1+\sqrt{3}\tan\theta=3\tan\theta$	dM1
	$\Rightarrow \tan\theta=\dfrac{1}{3-\sqrt{3}}$	
	$\Rightarrow \tan\theta=\dfrac{1}{6}\left(3+\sqrt{3}\right)$ *	A1*
		(4)
(b)	Deduces that $\theta=2x-10°$	B1
	$\tan(2x\pm\alpha)=\dfrac{1}{6}\left(3+\sqrt{3}\right)\Rightarrow 2x\pm\alpha=$ awrt 38 or 218 $\Rightarrow x=...$	M1
	$x=$ awrt 24.1°, awrt 114.1°.	A1
		(3)
		(7 marks)

(a)

M1 Attempts to use $\cos(\theta-60°)=\cos\theta\cos 60°\pm\sin\theta\sin 60°$ within the given equation

Condone the omission of a 2 on the second term and a slip on the 3 of $3\sin\theta$

A1 Correct equation in $\sin\theta$ and $\cos\theta$

dM1 Dependent on the first M1. Uses $\cos 60°=\dfrac{1}{2}, \sin 60°=\dfrac{\sqrt{3}}{2}$ AND attempts one of:

- Dividing all 3 terms by $\cos\theta$ or $\sin\theta$ to set up an equation in just $\tan\theta$; or
- Collecting terms in $\sin\theta$ to form an equation of the form $P\sin\theta\pm Q\cos\theta=0$ o.e.

A1* Correctly proceeds to given answer showing all necessary steps: **see the steps set out in the main scheme above**. It is not necessary to see the rationalising of the denominator. Withhold this mark for invisible brackets or for use of the wrong variable, e.g. x, or a missing variable, at any stage within the body of the solution.

(b) **Notes**

- **Correct answers from no working score B0 M0 A0**
- **This is a "hence" question, so starting from scratch also scores B0 M0 A0**

B1 Deduces that $\theta=2x-10°$

M1 Attempts correct method from $\tan(2x\pm\alpha)=\dfrac{1}{6}\left(3+\sqrt{3}\right)\Rightarrow x=....$

Look for the correct order of operations, i.e. arctan, then add or subtract α, then divide by 2.

As a minimum look for $\tan(2x\pm\alpha)=\dfrac{1}{6}\left(3+\sqrt{3}\right)\Rightarrow 2x\pm\alpha=$ awrt 38 or 218 $\Rightarrow x=...$

If $\tan(2x\pm\alpha)$ is expanded to $\dfrac{\tan 2x\pm\tan\alpha}{1\mp\tan 2x\tan\alpha}$ then $\tan 2x$ must be made the subject using the correct order of operations before arctan and division by 2.

Calculations must be in degrees.

A1 $x=$ awrt 24.1°, awrt 114.1° and no others in the range.