Question Number	Scheme	Marks
1(a)	$(f(1)=)1-5+e=-1.281...<0$ $(f(2)=)2^2-5\times2+e^2=1.389...>0$	M1
	As there is a change of sign and $f(x)$ is continuous over the interval $[1, 2]$ then there is a root *	A1*
		(2)
(b)(i)	$x_2=\sqrt{5\times1-e^1}=$ awrt 1.5105	M1A1
(ii)	$\alpha=$ awrt 1.7340	A1
		(3)
		(5 marks)

Notes

(a)

M1: Attempts $f(1)$ and $f(2)$ with substitution seen or at least one correct to 1 d.p. rounded or truncated **and considers their signs**. Note showing f(1)f(2) < 0 is a consideration of signs and is sufficient for the "sign change" part of reasoning for the A1.

A1*: Must have

- both $f(1)$ and $f(2)$ correct (as expressions or correct values imply these, need not be labelled)
- reason, which must mention continuity and state or indicate sign change in some way
- conclusion, "hence root", or accept e.g. hence "f(x)=0 between x =1 and x = 2"

(b)

(i)

M1: Attempts to find x_2 using the iteration formula. Implied by sight of 1 embedded in the formula or awrt 1.5

A1: awrt 1.5105

(ii)

A1: awrt 1.7340 provided M1 has been scored. Allow 1.734 with trailing zero omitted.

Note 1.7340 only may be from a graphical calculator, so scores M0A0A0. There must be evidence (i.e. the M is scored) of an attempt at least one iteration first.

Question Number	Scheme	Marks
2(a)	$\text{ff}(6)=\text{f}\left("\frac{9}{2}"\right)=\frac{"9/2"+3}{"9/2"-4}=...;\ =15$	M1; A1
		(2)
(b)	$\text{f}^{-1}(x)=\frac{4x+3}{x-1}$	M1A1
	$x\in\mathbb{R},\ x\neq 1$	B1
		(3)
(c)	E.g. $\left(\frac{x+3}{x-4}\right)^2+5=7$ or $\frac{a+3}{a-4}=(\pm)\sqrt{7-5}$	M1
	$\Rightarrow x^2-22x+23=0\Rightarrow x=...$ or $(a+3)=(\pm)\sqrt{2}(a-4)\Rightarrow a=...$	dM1
	$(a=)11+7\sqrt{2}$ oe	A1
		(3)
		(8 marks)

Notes

(a)

M1: Substitutes $x=6$ into f and substitutes the result back into f to find a value for $\text{ff}(6)$

Alternatively substitutes $x=6$ into $\text{ff}(x)=\dfrac{\left(\frac{x+3}{x-4}\right)+3}{\left(\frac{x+3}{x-4}\right)-4}$ condoning slips.

A1: 15

(b)

M1: Changes the subject of $y=\frac{x+3}{x-4}$ or $x=\frac{y+3}{y-4}$ to $y=\frac{...x\pm 3}{...x\pm 1}$ or $x=\frac{...y\pm 3}{...y\pm 1}$

A1: Achieves $\text{f}^{-1}(x)=\frac{4x+3}{x-1}$. Accept $\text{f}^{-1}=...$ or $y=\ldots$ instead of $\text{f}^{-1}(x)=....$

B1: $x\neq 1$. The omission of $x\in\mathbb{R}$ is condoned. Accept alternative notations.

(c) Note this is M1A1A1 on epen but is being marked as M1dM1A1.

M1: Correct attempt to set up an equation in *x* or *a*. This will usually be $\left(\frac{x+3}{x-4}\right)^2+5=7$ but $\text{f}(a)=\text{g}^{-1}(7)$ may be used first. Score when a suitable equation is set up and allow if a minor slip or miscopy is made if the intention is clear.

dM1: Proceeds to solve for *x* or *a*, e.g. forms a 3TQ and solves, or take the 5 across, square roots, cross multiplies and makes *a* the subject, condoning e.g. sign slips when rearranging.

Alternatively, uses $(\text{f}(x))^2+5=7\Rightarrow\text{f}(x)=(\pm)\sqrt{2}$ and their part (b) leading to $a=\text{f}^{-1}("\sqrt{2}")=\frac{"4\sqrt{2}+3"}{"\sqrt{2}-1"}$. In this method both M's may be scored together.

A1 $11+7\sqrt{2}$ or $\frac{4\sqrt{2}+3}{\sqrt{2}-1}$ Accept $11+\sqrt{98}$ or $\frac{-4\sqrt{2}-3}{1-\sqrt{2}}$. Common factors should be cancelled.

Ignore labelling of *x* or *a*. Condone e.g. if $11-7\sqrt{2}$ is also given as a solution but A0 if any other extra solutions are included.