Question Number	Scheme	Marks
2(a)	$\text{fg}(5) = \text{f}(3) = \frac{5-"3"}{3\times"3"+2}, = \frac{2}{11}$	M1, A1
		(2)
(b)	$\text{f}^{-1}(x) = \frac{5-2x}{3x+1}$	M1A1
	$x \in \mathbb{R},\ x \neq -\frac{1}{3}$	B1
		(3)
(c)	$\frac{5-\frac{1}{a}}{3\times\frac{1}{a}+2} = 2(a+3)-7$	B1ft
	$\frac{5-\frac{1}{a}}{3\times\frac{1}{a}+2} = 2(a+3)-7 \Rightarrow 4a^2-a-2=0$	M1A1
	$(a=)\ \frac{1\pm\sqrt{33}}{8}$	A1
		(4)
		(9 marks)

(a)

M1 Correct order of operations applying g before f on 5

Allow an attempt to substitute $x=5$ into $\text{fg}(x) = \frac{5-(2x-7)}{3(2x-7)+2}$ condoning slips. They must proceed to find a value.

This may be completed in two steps so allow for an attempt at $\text{g}(5) = A \rightarrow \text{f}(A) = ...$

Condoning arithmetical slips and bracket errors/omissions.

A1 $\frac{2}{11}$ or exact equivalent. Accept $0.\dot{1}\dot{8}$ but not eg 0.18 or 0.18….

(b)

M1 Changes the subject of $y = \frac{5-x}{3x+2} \rightarrow x = \frac{...\pm 2y}{\pm 3y \pm ...}$ or $x = \frac{5-y}{3y+2} \rightarrow y = \frac{...\pm 2x}{\pm 3x \pm ...}$

A1 $\mathrm{f}^{-1}(x)=\dfrac{5-2x}{3x+1}$ or $\mathrm{f}^{-1}(x)=\dfrac{2x-5}{-3x-1}$ or exact equivalent expressions such as $\mathrm{f}^{-1}(x)=\dfrac{5-2x}{3\left(x+\dfrac{1}{3}\right)}$

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Accept $\mathrm{f}^{-1}: x\to\dfrac{5-2x}{3x+1}$ Condone $\mathrm{f}^{-1}=...$ (or $\mathrm{f}^{-1}=y=...$) but **do not allow just** $y=...$ or $\mathrm{f}^{-1}: y=...$

B1 $x\neq-\dfrac{1}{3}$. The omission of $x\in\mathbb{R}$ is condoned.

Note: It is also acceptable to define f^{-1} in any variable eg as $\mathrm{f}^{-1}(t)=\dfrac{5-2t}{3t+1}\quad t\neq-\dfrac{1}{3}$ as long as the variable is used consistently to score M1A1B1. If another variable is used other than *x* it must be fully defined eg $\mathrm{f}^{-1}(t)=...$ not just $\mathrm{f}^{-1}=...$

(c)

B1ft Sets $\dfrac{5-\frac{1}{a}}{3\times\frac{1}{a}+2}=2(a+3)-7$ or their $\dfrac{1}{a}=\mathrm{f}^{-1}(2a-1)\Rightarrow\dfrac{1}{a}=\dfrac{"5"-"2"(2a-1)}{"3"(2a-1)+"1"}$

(may be in terms of *x*). Follow through on their $\mathrm{f}^{-1}(x)$.
May be implied by later work if they have invisible brackets.

M1 They must start with an equation of one of these forms (which may be in *x*):

- $\dfrac{A\pm\dfrac{1}{a}}{B\times\dfrac{1}{a}\pm C}=Da+E$ or equivalent so typically look for $\dfrac{5-\frac{1}{a}}{3\times\frac{1}{a}+2}=2(a+3)-7$

  (may be manipulated to $\dfrac{Aa\pm1}{B\pm Ca}=Da+E$)

- $\dfrac{1}{a}=\dfrac{Aa\pm B}{Ca\pm D}$ or equivalent

Rearranges their equation of an allowable form to a 3TQ. They must be attempting to solve $\mathrm{f}\left(\dfrac{1}{a}\right)=\mathrm{g}(a+3)$ so it cannot be awarded for an attempt to solve $\mathrm{f}\left(a\right)=\mathrm{g}(a)$ or $\mathrm{f}\left(\dfrac{1}{a}\right)=\mathrm{g}\left(\dfrac{1}{a}\right)$

Do not be concerned with the mechanics of their arrangement and condone invisible brackets.

A1 $4a^2-a-2=0$ or equivalent equation involving 3 terms. Eg $4a^2-a=2$ (may be in terms of *x*). May be implied by awrt ±0.843 and the = 0 may be implied by their attempt to solve their quadratic equation.

A1 $\left(a=\right)\dfrac{1\pm\sqrt{33}}{8}$ or exact equivalent. Do not accept rounded decimals. Condone $x=\dfrac{1\pm\sqrt{33}}{8}$

Question Number	Scheme	Marks
3(a)	$\int \frac{9x}{3x^2+k}\,\mathrm{d}x = \frac{3}{2}\ln\left(3x^2+k\right)+C$	M1A1
		(2)
(b)	$\frac{3}{2}\ln(75+k)-\frac{3}{2}\ln(12+k)=\ln 8$	M1
	$\frac{3}{2}\ln\left(\frac{75+k}{12+k}\right)=\ln 8$ oe	dM1
	$\frac{75+k}{12+k}=4\Rightarrow k=...$	ddM1
	$(k=)\ 9$	A1
		(4)
		(6 marks)

(a)

M1 Integrates to $A\ln(3x^2+k)$ with or without the + *C*. Allow *A* = 1 for this mark. Condone invisible brackets.

A1 $\frac{3}{2}\ln\left(3x^2+k\right)+C$ or $\frac{3}{2}\ln B\left(3x^2+k\right)$ oe Must include the constant of integration that is different from *k*. Must have brackets around $3x^2+k$

Also allow eg $\ln\left[B\left(3x^2+k\right)\right]^{\frac{3}{2}}$