Question Number	Scheme	Marks
2.(a)	$\mathrm{fg}\left(\mathrm{e}^2\right)=\mathrm{f}\left(\frac{5}{2}\ln \mathrm{e}^2\right)=\frac{12}{\frac{5}{2}\ln \mathrm{e}^2+1},=2$	M1, A1
		(2)
(b)	$\mathrm{f}(x)=\frac{12}{x+1}$	
	$\mathrm{f}^{-1}(x)=\frac{12}{x}-1$	M1 A1
	$0<x<12$	B1
		(3)
(c)	$\frac{12}{x+1}=\frac{12}{x}-1\Rightarrow 12x=12(x+1)-x(x+1)$	M1
	$\Rightarrow x^2+x-12=0\Rightarrow x=...$ Must be 3TQ	dM1
	$x=3$ only	A1
		(3)
		8 marks
(c) Alts	Solves $\mathrm{f}^{-1}(x)=x\Rightarrow\frac{12}{x}-1=x$ leading to quadratic equation,	
	or solves $\mathrm{f}(x)=x\Rightarrow\frac{12}{x+1}=x$ leading to quadratic equation	M1
	$\Rightarrow x^2+x-12=0\Rightarrow x=...$ Must be 3TQ	dM1
	$x=3$ only	A1
		(3)

(a)

M1 Correct order of operations applying g before f on e^2.

Allow an attempt to substitute $x= e^2$ into $\mathrm{fg}(x)=\frac{12}{\frac{5}{2}\ln x+1}$

This must be a complete attempt using all aspects of both functions but allow for slips on the coefficients

A1 cso 2.

(b)

M1 Changes the subject of $y=\frac{12}{x+1}$ or $x=\frac{12}{y+1}$ to one of the appropriate forms. See below.

Allow for $x=\frac{12}{y}\pm 1$ or $x=\frac{12\pm y}{y}$ (Only error allowed is a slip in sign)

Or $y=\frac{12}{x}\pm 1$ or $y=\frac{12\pm x}{x}$ when x and y are swapped

A1 $\mathrm{f}^{-1}(x)=\frac{12}{x}-1$ or $\mathrm{f}^{-1}(x)=\frac{12-x}{x}$ **with correct notation**. Condone $\mathrm{f}^{-1}(x)=y=\frac{12}{x}-1$

$\mathrm{f}^{-1}:x\mapsto\frac{12}{x}-1$ is fine as is any other variable used consistently, e.g. $\mathrm{f}^{-1}(y)=\frac{12}{y}-1$

but $\mathrm{f}^{-1}=\frac{12}{x}-1$ is A0 (as it is incomplete) and $y=\frac{12}{x}-1$ is also A0 (not set in the appropriate form)

B1 Gives a correct domain for the function $0<x<12$ or equivalent "Domain $\in(0,12)$"

(c)

M1 Attempts to set $\mathrm{f}^{-1}(x)=\mathrm{f}(x)$, $\mathrm{f}^{-1}(x)=x$ $\mathrm{ff}(x)=x$ or $\mathrm{f}(x)=x$ and proceeds to a quadratic equation

The quadratic equation does not need to be simplified. Allow this mark for using **their** $\mathrm{f}^{-1}(x)$

dM1 Solves a 3TQ leading to at least one value for x. Apply the usual rules.
This is dependent upon the previous M mark

A1 $x=3$ only

Question Number	Scheme	Marks
3.(a)	Implies equation of line is of the form $\log_{10} y = \pm\frac{2}{3}\log_{10} x + 4$	M1
	States $\log_{10} y = -\frac{2}{3}\log_{10} x + 4$ o.e.	A1
		(2)
(b)	Applies one correct log law E.g $\log_{10} y = -\frac{2}{3}\log_{10} x + 4 \rightarrow \log_{10} y = \log_{10} x^{-\frac{2}{3}} + 4$	M1
	Full attempt to undo the logs $\log_{10} y = \log_{10} x^{-\frac{2}{3}} + \log_{10} 10^4 \rightarrow y = x^{-\frac{2}{3}} \times 10^4$	dM1
	$\rightarrow y = 10\,000x^{-\frac{2}{3}}$ o.e.	A1
		(3)
		5 marks

Note that other versions of $\log_{10}$ are acceptable. So allow $\log_{10} \leftrightarrow \log$ and $\log_{10} \leftrightarrow \lg$

(a)

M1 Implies equation of line is of the form $\log_{10} y = \pm\frac{2}{3}\log_{10} x + 4$ oe

(Eg allow for M1 A0 $\log_{10} y = \pm 0.67\log_{10} x + 4$) Condone $"y" = \pm\frac{2}{3}"x" + 4$ here

A1 $\log_{10} y = -\frac{2}{3}\log_{10} x + 4$ oe such as $3\log_{10} y + 2\log_{10} x = 12$

Allow unsimplified equations such as $\log_{10} y = -\frac{4}{6}\log_{10} x + 4$

This may be implied by the constants if the full equation is used in part (b).
So marks in (a) can be awarded from work in (b).

(b) **Main Method: Starting from $\log_{10} y = a\log_{10} x + b$ and working towards $y = px^q$**

M1 Uses one correct log law. Look for either

$\log_{10} y = a\log_{10} x + b \rightarrow \log_{10} y = \log_{10} x^a + b$

$\log_{10} y = a\log_{10} x + b \rightarrow \log_{10} y = a\log_{10} x + \log_{10} 10^b$

$\log_{10} y = a\log_{10} x + b \rightarrow y = 10^{a\log_{10} x + b}$

dM1 A full attempt to get y in terms of x or values of p and q
Cannot be awarded from easier equations, e.g. where $b = 0$

Look for $\log_{10} y = a\log_{10} x + b \rightarrow y = x^a \times 10^b$

A1 $y = 10\,000x^{-\frac{2}{3}}$ but condone $y = 10^4 x^{-\frac{2}{3}}$

This requires the equation and not just the values of p and q
It is acceptable to just write down the answer, but it must follow a correct part (a)