(b)	$\log_{10} y = -\frac{4}{7}\log_{10} x - 2 \Rightarrow$ $y = 10^{\left(-\frac{4}{7}\log_{10} x - 2\right)}$ or $y = 10^{\left(\log_{10} x^{-\frac{4}{7}} - 2\right)}$ or $y = 10^{-\frac{4}{7}\log_{10} x} \times 10^{-2}$ or e.g. $\log_{10} y = \log_{10} x^{-\frac{4}{7}} - 2 \Rightarrow \log_{10} \frac{y}{x^{-\frac{4}{7}}} = -2$ or e.g. $\log_{10} y = -\log_{10} x^{\frac{4}{7}} - 2 \Rightarrow \log_{10} yx^{\frac{4}{7}} = -2$	M1
	$y = 10^{\left(\log_{10} x^{-\frac{4}{7}} - 2\right)}$ or $y = 10^{-\frac{4}{7}\log_{10} x} \times 10^{-2} \Rightarrow y = x^{-\frac{4}{7}} \times 10^{-2}$ or e.g. $10^{\log_{10} \frac{y}{x^{-\frac{4}{7}}}} = 10^{-2} \Rightarrow \frac{y}{x^{-\frac{4}{7}}} = 10^{-2}$ or $10^{\log_{10} yx^{\frac{4}{7}}} = 10^{-2} \Rightarrow yx^{\frac{4}{7}} = 10^{-2}$	dM1
	$y = \frac{1}{100} x^{-\frac{4}{7}}$ oe	A1
		(3)
		Total 5

Do not allow marks for part (a) to be scored in part (b)

Main method: Starting from an equation of the form $\log_{10} y = m\log_{10} x + c$ where m and c are non-zero.

M1: Correctly applies $10^{\text{lhs}} = 10^{\text{rhs}}$ to their $\log_{10} y = m\log_{10} x + c$ including the use of $10^{\log_{10} y} = y$

e.g. $\log_{10} y = m\log_{10} x + c \Rightarrow y = 10^{m\log_{10} x + c}$ or $\log_{10} y = m\log_{10} x + c \Rightarrow y = 10^{m\log_{10} x} \times 10^{c}$

or combines their $\log_{10} y$ and $m\log_{10} x$ correctly to obtain $\log_{10} yx^{m} = \pm c$ or equivalent e.g.

$\log_{10} y = m\log_{10} x + c \Rightarrow \log_{10} y = \log_{10} x^{m} + c \Rightarrow \log_{10} y - \log_{10} x^{m} = c \Rightarrow \log_{10} \frac{y}{x^{m}} = \pm c$

May be implied by their work. Note that e.g.

$\log_{10} y = -\frac{4}{7}\log_{10} x - 2 \Rightarrow y = 10^{-\frac{4}{7}\log_{10} x} - 10^{2}$ scores M0

dM1: Depends on the previous method mark.

Complete and correct work to obtain an equation in x and y only or for obtaining values for p and q which must not involve logs.

You can condone sign slips with their constant term but the log work must be correct.

A1: Correct **<u>equation</u>** in the form required $y = \frac{1}{100} x^{-\frac{4}{7}}$ or e.g. $y = 0.01x^{-\frac{4}{7}}$ or e.g. $y = 10^{-2} x^{-\frac{4}{7}}$ or e.g.

$y = \frac{x^{-\frac{4}{7}}}{100}$ from correct work. Allow equivalent exact values for q e.g. $q = -\frac{8}{14}$ but not e.g. $q = -\frac{2}{3.5}$

Note that the correct answer does not imply the method marks and you need to check carefully.

Alternatives for part (b):

Way 2:

M1: Starts with $y = px^q$ and obtains $\log_{10} y = \log_{10} p + \log_{10} x^q$ oe e.g. $\log_{10} y = \log_{10} p + q\log_{10} x$

dM1: **Depends on the previous method mark.**

Correct attempt at p **and** q by comparing their equation of the form $\log_{10} y = m\log_{10} x + c$ from part (a) or e.g. identifies the gradient and y-intercept from the sketch to obtain values for p and q not involving logs e.g. $\log_{10} p = c \Rightarrow p = 10^c$ and $\log_{10} x^q = q\log_{10} x \Rightarrow q = m$

A1: Correct **<u>equation</u>** in the form required $y = \frac{1}{100}x^{-\frac{4}{7}}$ or e.g. $y = 0.01x^{-\frac{4}{7}}$ or e.g. $y = 10^{-2}x^{-\frac{4}{7}}$ from correct work. Allow equivalent exact values for q e.g. $q = -\frac{8}{14}$ but not e.g. $q = -\frac{2}{3.5}$

Note that correct values for p and q with no incorrect work seen scores M1dM1

Note that a correct equation with no incorrect work seen scores M1dM1A1

Way 3:

M1: $7\log_{10} y + 4\log_{10} x = -14 \Rightarrow \log_{10} y^7x^4 = -14 \Rightarrow y^7x^4 = 10^{-14}$

Multiplies up to obtain integer coefficients, combines the log terms correctly then applies $10^{\text{lhs}} = 10^{\text{rhs}}$

dM1: $y^7x^4 = 10^{-14} \Rightarrow y = \sqrt[7]{\frac{10^{-14}}{x^4}}$

Complete and correct attempt to obtain y in terms of x.

A1: Correct **<u>equation</u>** in the form required $y = \frac{1}{100}x^{-\frac{4}{7}}$ or e.g. $y = 0.01x^{-\frac{4}{7}}$ or e.g. $y = 10^{-2}x^{-\frac{4}{7}}$ or e.g. $y = \frac{x^{-\frac{4}{7}}}{100}$ from correct work. Allow equivalent exact values for q e.g. $q = -\frac{8}{14}$ but not e.g. $q = -\frac{2}{3.5}$

Way 4:

M1: $(\log_{10} x,\ \log_{10} y) = (0, -2) \Rightarrow x = 1,\ y = 10^{-2} \Rightarrow p = 10^{-2}$

Uses $(0, -2)$ correctly to establish the value of p.

dM1: $(\log_{10} x,\ \log_{10} y) = (-3.5,\ 0) \Rightarrow y = 1,\ x = 10^{-3.5} \Rightarrow 1 = 10^{-2} \times 10^{-3.5q} \Rightarrow -2 - 3.5q = 0 \Rightarrow q = ...$

Uses $(-3.5,\ 0)$ correctly with their value of p to obtain a value for q.

A1: Correct **<u>equation</u>** in the form required $y = \frac{1}{100}x^{-\frac{4}{7}}$ or e.g. $y = 0.01x^{-\frac{4}{7}}$ or e.g. $y = 10^{-2}x^{-\frac{4}{7}}$ or e.g. $y = \frac{x^{-\frac{4}{7}}}{100}$ from correct work. Allow equivalent exact values for q e.g. $q = -\frac{8}{14}$ but not e.g. $q = -\frac{2}{3.5}$

Fully correct answer in (b) with **no** working scores full marks in (b).

Partially correct answer in (b) with no working scores no marks.

Question Number	Scheme	Marks
4(a)	$\dfrac{49x}{x^2+x-12}+\dfrac{7x}{x+4}=\dfrac{49x+7x(x-3)}{(x+4)(x-3)}$ or e.g. $\dfrac{49x(x+4)}{(x^2+x-12)(x+4)}+\dfrac{7x(x^2+x-12)}{(x+4)(x^2+x-12)}=\dfrac{49x(x+4)+7x(x^2+x-12)}{(x+4)(x^2+x-12)}$	M1A1
	$\dfrac{49x+7x(x-3)}{(x+4)(x-3)}=\dfrac{49x+7x^2-21x}{(x+4)(x-3)}=\dfrac{7x^2+28x}{(x+4)(x-3)}$ $=\dfrac{7x\cancel{(x+4)}}{\cancel{(x+4)}(x-3)}=\dfrac{7x}{(x-3)}$ *	A1*
		(3)

Do not allow a mis-read of the numerators of the fractions e.g. $\dfrac{7x}{x+4}$ as $\dfrac{7}{x+4}$ or $\dfrac{49x}{x^2+x-12}$ as $\dfrac{49}{x^2+x-12}$

M1: Factorises the denominator of the first term to obtain $(x+4)(x\pm3)$ and attempts to combine the two fractions using a common denominator to obtain $\dfrac{49x}{x^2+x-12}+\dfrac{7x}{x+4}=\dfrac{...x+...x(x\pm3)}{(x+4)(x\pm3)}$ oe

Alternatively multiplies numerator and denominator of both fractions by suitable expressions and attempts to combine the two fractions e.g.

$$\frac{49x(x+4)}{(x^2+x-12)(x+4)}+\frac{7x(x^2+x-12)}{(x+4)(x^2+x-12)}=\frac{...x(x+4)+...x(x^2+x-12)}{(x+4)(x^2+x-12)}$$

A1: For a correct unsimplified fraction.
Condone missing brackets if they are recovered.

A1*: Achieves the printed answer with sufficient working shown.
The factorisation required for the cancelling needs to be seen within their fraction so that e.g.

$\dfrac{49x}{x^2+x-12}+\dfrac{7x}{x+4}=\dfrac{49x+7x(x-3)}{(x+4)(x-3)}=\dfrac{7x^2+28x}{(x+4)(x-3)}=\dfrac{7x}{(x-3)}$ scores M1A1A0*

Do **not** allow just $\dfrac{7x\cancel{(x+4)}}{\cancel{(x+4)}(x-3)}$ without the printed answer written down.

For reference if they take the more complicated method, the correct working to reach the printed could be as follows:

$$=\frac{49x(x+4)+7x(x^2+x-12)}{(x+4)(x^2+x-12)}=\frac{7x(x^2+8x+16)}{(x+4)(x+4)(x-3)}=\frac{7x(x+4)(x+4)}{(x+4)(x+4)(x-3)}=\frac{7x}{(x-3)}*$$

(b)	$f(x)=\frac{7x}{(x-3)} \Rightarrow f'(x)=\frac{(x-3)\times 7-7x\times 1}{(x-3)^2}$	M1
	$f(x)=\frac{7x}{(x-3)} \Rightarrow f'(x)=-\frac{21}{(x-3)^2}$	A1
		(2)
(b) ALT	$f(x)=\frac{7x}{(x-3)}=7+\frac{21}{x-3} \Rightarrow f'(x)=-\frac{21}{(x-3)^2}$	M1A1
		Total 5

(b)

M1: Attempts to differentiate using the quotient rule or product rule.

For the quotient rule it requires achieving $f'(x)=\frac{\alpha(x-3)-\beta x}{(x-3)^2}$ $\alpha,\beta>0$

If they use a substitution then similar conditions apply e.g. $u=x-3 \Rightarrow f'(u)=\frac{\alpha u-\beta(u+3)}{u^2}$ $\alpha,\beta>0$

For the product rule it requires achieving $f'(x)=A(x-3)^{-1}-Bx(x-3)^{-2}$ $A,B>0$

If they use a substitution then similar conditions apply e.g. $u=x-3 \Rightarrow f'(u)=Au^{-1}-B(u+3)u^{-2}$ $A,B>0$

A1: Correct simplified expression. Allow simplified equivalents e.g. $-21(x-3)^{-2}$

Allow $-\frac{21}{x^2-6x+9}$ or e.g. $-21(x^2-6x+9)^{-1}$

Isw once a correct simplified answer is seen.

Alternative:

M1: Expresses $\frac{7x}{(x-3)}$ as $\alpha+\frac{\beta}{(x-3)}$ and differentiates to obtain $\frac{\ldots}{(x-3)^2}$ or e.g. $\alpha+\frac{\beta}{u}$ where $u = x - 3$

and differentiates to obtain $\frac{\ldots}{u^2}$

A1: Correct simplified expression. Allow simplified equivalents e.g. $-21(x-3)^{-2}$

Allow $-\frac{21}{x^2-6x+9}$ or e.g. $-21(x^2-6x+9)^{-1}$

Isw once a correct simplified answer is seen.