Question	Scheme	Marks	AOs
13 (a)	(i) **Explains** $2x-q=0$ when $x=2$ oe Hence $q=4$ *	B1*	2.4
	(ii) Substitutes $\left(3,\frac{1}{2}\right)$ into $y=\frac{p-3x}{(2x-4)(x+3)}$ and solves	M1	1.1b
	$\frac{1}{2}=\frac{p-9}{(2)\times(6)}\Rightarrow p-9=6\Rightarrow p=15$ *	A1*	2.1
		(3)	
(b)	Attempts to write $\frac{15-3x}{(2x-4)(x+3)}$ in PF's and integrates using lns between 3 and another value of x.	M1	3.1a
	$\frac{15-3x}{(2x-4)(x+3)}=\frac{A}{(2x-4)}+\frac{B}{(x+3)}$ leading to A and B	M1	1.1b
	$\frac{15-3x}{(2x-4)(x+3)}=\frac{1.8}{(2x-4)}-\frac{2.4}{(x+3)}$ or $\frac{0.9}{(x-2)}-\frac{2.4}{(x+3)}$ oe	A1	1.1b
	$\mathrm{I}=\int\frac{15-3x}{(2x-4)(x+3)}\mathrm{d}x=m\ln(2x-4)+n\ln(x+3)+(c)$	M1	1.1b
	$\mathrm{I}=\int\frac{15-3x}{(2x-4)(x+3)}\mathrm{d}x=0.9\ln(2x-4)-2.4\ln(x+3)$ oe	A1ft	1.1b
	Deduces that Area Either $\int_3^5\frac{15-3x}{(2x-4)(x+3)}\mathrm{d}x$ Or $[.............]_3^5$	B1	2.2a
	Uses correct ln work seen at least once for $\ln 6=\ln 2+\ln 3$ **or** $\ln 8=3\ln 2$ $[0.9\ln(6)-2.4\ln(8)]-[0.9\ln(2)-2.4\ln(6)]$ $=3.3\ln 6-7.2\ln 2-0.9\ln 2$	dM1	2.1
	$=3.3\ln 3-4.8\ln 2$	A1	1.1b
		(8)	
			(11marks)

(a)

B1*: Is able to link $2x-q=0$ and $x=2$ to explain why $q=4$

Eg "The asymptote $x=2$ is where $2x-q=0$ so $4-q=0 \Rightarrow q=4$"

"The curve is not defined when $2\times 2-q=0 \Rightarrow q=4$"

There **must be some words** explaining why $q=4$ and in most cases, you should see a reference to either "the asymptote $x=2$", "the curve is not defined at $x=2$", 'the denominator is 0 at $x=2$"

M1: Substitutes $\left(3,\frac{1}{2}\right)$ into $y=\dfrac{p-3x}{(2x-4)(x+3)}$ and solves

Alternatively substitutes $\left(3,\frac{1}{2}\right)$ into $y=\dfrac{15-3x}{(2x-4)(x+3)}$ and shows $\dfrac{1}{2}=\dfrac{6}{(2)\times(6)}$ oe

A1*: Full proof showing all necessary steps $\dfrac{1}{2}=\dfrac{p-9}{(2)\times(6)} \Rightarrow p-9=6 \Rightarrow p=15$

In the alternative there would have to be some recognition that these are equal eg ✓ hence $p=15$

(b)

M1: Scored for an overall attempt at using PF's and integrating with lns seen with sight of limits 3 and another value of x.

M1: $\dfrac{15-3x}{(2x-4)(x+3)}=\dfrac{A}{(2x-4)}+\dfrac{B}{(x+3)}$ leading to A and B

A1: $\dfrac{15-3x}{(2x-4)(x+3)}=\dfrac{1.8}{(2x-4)}-\dfrac{2.4}{(x+3)}$, or for example $\dfrac{0.9}{(x-2)}-\dfrac{2.4}{(x+3)}$, $\dfrac{9}{(10x-20)}-\dfrac{12}{(5x+15)}$ oe

Must be written in PF form, not just for correct A and B

M1: Area $R=\displaystyle\int\frac{15-3x}{(2x-4)(x+3)}\,\mathrm{d}x=m\ln(2x-4)+n\ln(x+3)$

OR $\displaystyle\int\frac{15-3x}{(2x-4)(x+3)}\,\mathrm{d}x=m\ln(x-2)+n\ln(x+3)$

Note that $\displaystyle\int\frac{l}{(x-2)}\,\mathrm{d}x \to l\ln(kx-2k)$ and $\displaystyle\int\frac{m}{(x+3)}\,\mathrm{d}x \to m\ln(nx+3n)$

A1ft: $=\displaystyle\int\frac{15-3x}{(2x-4)(x+3)}\,\mathrm{d}x=0.9\ln(2x-4)-2.4\ln(x+3)$ oe. FT on their A and B

B1: Deduces that the limits for the integral are 3 and 5. It cannot just be awarded from 5 being marked on Figure 4. So award for sight of $\displaystyle\int_3^5\frac{15-3x}{(2x-4)(x+3)}(\mathrm{d}x)$ or $[.............]_3^5$ having performed an integral which may be incorrect

dM1: Uses correct ln work seen at least once eg $\ln 6=\ln 2+\ln 3$, $\ln 8=3\ln 2$ or $m\ln 6k-m\ln 2k=m\ln 3$

This is an attempt to get either of the above ln's in terms of ln2 and/or ln3

It is dependent upon the correct limits and having achieved $m\ln(2x-4)+n\ln(x+3)$ oe

A1: $=3.3\ln 3-4.8\ln 2$ oe