Question	Scheme	Marks
5(a)	$y=\dfrac{2}{t(3-t)}=1\Rightarrow 2=3t-t^2\Rightarrow t=...$	**M1**
	$\left(t^2-3t+2=\left(t-1\right)\left(t-2\right)=0\Rightarrow\right)a=1,b=2$	**A1**
		(2)
(b)	Area under curve $=\displaystyle\int_{t="1"}^{t="2"} y\,\mathrm{d}x=\int_1^2 y\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t=\int_1^2\frac{2}{t(3-t)}\times(2t+2)\,\mathrm{d}t$	**M1 A1**
	$t=1\Rightarrow x=3,\quad t=2\Rightarrow x=8$	**B1**
	So area of $R=1\times\left(8-3\right)-\displaystyle\int_1^2\frac{2}{t(3-t)}\times(2t+2)\,\mathrm{d}t$	**M1**
	$=5-4\displaystyle\int_1^2\frac{t+1}{t(3-t)}\mathrm{d}t$	**A1**
		(5)
(c)(i)	$\dfrac{t+1}{t(3-t)}=\dfrac{A}{t}+\dfrac{B}{3-t}$	**M1**
	$\Rightarrow t+1=A(3-t)+Bt$ E.g. $t=0\Rightarrow 1=3A\Rightarrow A=\dfrac{1}{3}$; $t=3\Rightarrow 4=3B\Rightarrow B=\dfrac{4}{3}$	**M1**
	$\dfrac{t+1}{t(3-t)}=\dfrac{1}{3t}+\dfrac{4}{3(3-t)}$	**A1**
(ii)	$\displaystyle\int\frac{t+1}{t(3-t)}\mathrm{d}t=\int\frac{1}{3t}+\frac{4}{3(3-t)}\mathrm{d}t=\frac{1}{3}\ln t-\frac{4}{3}\ln\left(3-t\right)$	**M1**
	$\text{Area}=5-4\left[\dfrac{1}{3}\ln t-\dfrac{4}{3}\ln\left(3-t\right)\right]_1^2=5-4\left(\dfrac{1}{3}\ln 2-\dfrac{4}{3}\ln 1-\dfrac{1}{3}\ln 1+\dfrac{4}{3}\ln 2\right)$ $=5-4\left(\dfrac{1}{3}\ln 2+\dfrac{4}{3}\ln 2\right)$	**dM1**
	$=5-\dfrac{20}{3}\ln 2$	**A1**
		(6)
		(13 marks)

(a)

M1: **S**ets the y equation equal to 1 (condoning slips) and then attempts to solve the resulting quadratic equation (usual rules). May be implied by correct values if a calculator is used.

A1: Correct values. That is $a=1$ and $b=2$. Condone (t =) 1 and 2 due to the demand of the question. Correct answers with no (incorrect) working scores both marks but must be seen in part (a).

If they do state $a=3$ and $b=8$ following $t=1$ and $t=2$ score A0

(b) M1: Attempts $\frac{\mathrm{d}x}{\mathrm{d}t}$ and multiplies by y condoning slips (e.g. missing brackets).

No requirement to see any integral.

A1: Correct unsimplified expression for the area under the curve $\int_{"1"}^{"2"} \frac{2}{t(3-t)} \times (2t+2)\,\mathrm{d}t$

Allow with their a and b or even with a and b (as letters). May be seen within an expression.

Condone the omission of the dt for this mark. Allow missing brackets to be recovered.

B1: Sight of correct (x) values 3 and 8 at the ends of the given curve. May be awarded from work done in (a). Award for sight of 5 as the width of the rectangle or for $5-\int$ as their attempt at the area of R

M1: Full attempt at finding the area of region R. Be aware that the form is given.

Look for the area of the rectangle subtract the area under the curve. dt's not required here

It is dependent upon

Use of the correct x_a and x_b or use of their t values from (a) to find x_a and x_b which may be implied by the width of the rectangle

Use of $1\times\left(x_b - x_a\right) - \int_{"1"}^{"2"} y\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t$ to find area of R.

May be achieved by $\int_{t="1"}^{t="2"} \left(1-y\right)\mathrm{d}x = \int_1^2 \left(1-y\right)\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t = \int_1^2 \left(2t+2\right) - \frac{4\left(t+1\right)}{t(3-t)}\mathrm{d}t = \left[t^2+2t\right]_1^2 - \int_1^2 \frac{4\left(t+1\right)}{t(3-t)}\mathrm{d}t$

A1: Correct answer achieved. All aspects including the dt must be present at least once before the final solution

(c)(i)

M1: Correct form for partial fractions which may be implied

M1: Correct method to find at least one of the constants.

If they use cover up rule etc it may be implied by one correct constant or one correct pf

A1: Correct partial fractions, not just correct constants. May be awarded in (c)(ii)

Allow fractions like $\frac{1/3}{t} + \frac{4/3}{(3-t)}$. Ignore any … which may be set equal to this.

(c)(ii)

M1: Integrates to correct form $p\ln t + q\ln(3-t)$ o.e.

Be aware that $p\ln ct + q\ln k(3-t)$ where c and k are constants is also correct

dM1: Substitutes their t limits (either way around) and uses the answer from (b) to find the area.

There must be some correct ln work seen. E.g $\ln 1 = 0$ or attempts to combine terms

To score this there must be non-zero values for M, k, a and b.

Condone with M and k leading to a correct expression in M and k. E.g. $M - K\left(\frac{1}{3}\ln 2 + \frac{4}{3}\ln 2\right)$

It is dependent upon the previous M1 and must be of the form $M - K"\left(\frac{1}{3}\ln 2 + \frac{4}{3}\ln 2\right)"$

A1: Correct answer or equivalent simplest form. E.g. $\frac{15-20\ln 2}{3}$. ISW after a correct answer.

Condone other simple equivalents such as $5-\frac{5}{3}\ln 16$ or $5-\frac{4}{3}\ln 32$

Question	Scheme	Marks
6(a)	$\left\|\overrightarrow{OA}\right\|^2 = \left(1+8\lambda\right)^2 + \left(2-\lambda\right)^2 + \left(5+4\lambda\right)^2$	**M1**
	$\left\|\overrightarrow{OA}\right\| = 5\sqrt{10} \Rightarrow \left(1+8\lambda\right)^2 + \left(2-\lambda\right)^2 + \left(5+4\lambda\right)^2 = 250$	**M1**
	$\Rightarrow 64\lambda^2 + 16\lambda + 1 + \lambda^2 - 4\lambda + 4 + 16\lambda^2 + 40\lambda + 25 = 250$ $\Rightarrow 81\lambda^2 + 52\lambda - 220 = 0$*	**A1***
		(3)
(b)	$81\lambda^2 + 52\lambda - 220 = 0 \Rightarrow \left(81\lambda - 110\right)\left(\lambda + 2\right) = 0 \Rightarrow \lambda = ... \left(-2, \frac{110}{81}\right)$ $\Rightarrow \overrightarrow{OA} = \begin{pmatrix} 1+8\times"\text{their}\lambda" \\ 2-"\text{their}\lambda" \\ 5+4\times"\text{their}\lambda" \end{pmatrix}$	**M1**
	E.g $\Rightarrow \overrightarrow{OA} = \begin{pmatrix} 1 \\ 2 \\ 5 \end{pmatrix} - 2\begin{pmatrix} 8 \\ -1 \\ 4 \end{pmatrix} = \begin{pmatrix} -15 \\ 4 \\ -3 \end{pmatrix}$* ; or $\overrightarrow{OA} = \begin{pmatrix} 1+8\times\frac{110}{81} \\ 2-\frac{110}{81} \\ 5+4\times\frac{110}{81} \end{pmatrix} = \begin{pmatrix} \frac{961}{81} \\ \frac{52}{81} \\ \frac{845}{81} \end{pmatrix}$	**A1*;** **A1**
		(3)
(c)	$\cos\theta = \pm\frac{\begin{pmatrix} -15 \\ 4 \\ -3 \end{pmatrix}.\begin{pmatrix} 8 \\ -1 \\ 4 \end{pmatrix}}{\sqrt{15^2+4^2+3^2}\sqrt{8^2+1^2+4^2}} = ...$	**M1**
	$= \pm\frac{-136}{45\sqrt{10}}$ $\left(= \pm 0.9557...\right)$ or e.g. $\theta =$ awrt $0.299\,(rad)$ / $17.1°$	**A1**
	Area $OAB = \frac{1}{2}5\sqrt{10}\times 4\sqrt{10}\sin\theta = ...$	**M1**
	= awrt 29.4	**A1**
		(4)
		(10 marks)

(a)

M1: Attempts to find the distance, or distance squared, from *O* to a general point on the line, or to *A*. Condone slips. It is acceptable to use a different variable rather than λ.

M1: Attempts to use $\left|\overrightarrow{OA}\right| = 5\sqrt{10}$ to set up a quadratic equation in λ, need not be expanded for this mark.

Condone slips on the 250 for OA^2 on this mark. Allow it to appear as $5\times 10 = 50$

A1*: Expands and reaches the correct equation from correct work.

An intermediate line equivalent to $64\lambda^2 + 16\lambda + 1 + \lambda^2 - 4\lambda + 4 + 16\lambda^2 + 40\lambda + 25 = 250$ must be written out before the final given answer is seen.