Question Number	Scheme	Marks
6.(a)	$x=\frac{3}{2}\Rightarrow a=\frac{\pi}{6}$	B1
	$\int y^2\mathrm{d}x=\int y^2\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t=\int(2\sin 2t)^2\,3\cos t\,(\mathrm{d}t)$	M1
	Uses $\sin 2t=2\sin t\cos t\ \Rightarrow\int(4\sin t\cos t)^2\,3\cos t\ \mathrm{d}t$	dM1
	Volume = $\int\pi y^2\mathrm{d}x=48\pi\int_0^{\left(\frac{\pi}{6}\right)}\sin^2 t\cos^3 t\ \mathrm{d}t$	A1
		(4)
(b)	$u=\sin t\Rightarrow\frac{\mathrm{d}u}{\mathrm{d}t}=\cos t$	B1
	$k\int\sin^2 t\cos^3 t\,\mathrm{d}t=k\int u^2\cos^2 t\,\mathrm{d}u$	
	$=k\int u^2(1-\sin^2 t)\,\mathrm{d}u=k\int u^2(1-u^2)\,\mathrm{d}u$	M1
	$=k\left[\frac{u^3}{3}-\frac{u^5}{5}\right]$	dM1
	Volume = $48\pi\left[\frac{u^3}{3}-\frac{u^5}{5}\right]_0^{\frac{1}{2}}=\frac{17\pi}{10}$	ddM1A1
		(5)
		(9 marks)

(a)

B1: $x=\frac{3}{2}\Rightarrow a=\frac{\pi}{6}$. This may be seen as the top limit on the integral

M1: Attempts $y^2\times\frac{\mathrm{d}x}{\mathrm{d}t}$

It will usually be seen within $\int y^2\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t\rightarrow\int(\ldots\sin 2t)^2\,(\pm)\delta\cos t\mathrm{d}t$, but you can condone bracketing issues and the loss of the integral signs as well as the dt

dM1: Uses $\sin 2t=2\sin t\cos t$ within their answer to $\int y^2\frac{\mathrm{d}x}{\mathrm{d}t}\mathrm{d}t\rightarrow\lambda\int\sin^2 t\cos^3 t\ \mathrm{d}t$

Note that the previous M mark must have been scored.

Condone $\sin^2 2t\rightarrow 2\sin^2 t\cos^2 t$ for this mark

The form of the answer is given so expect to see both the integral sign and the dt

A1: Volume = $48\pi\int_0^a \sin^2 t\cos^3 t\ \mathrm{d}t$. CSO

You can follow through on their value of *a*, $a \neq \frac{3}{2}$, but a value (not necessarily correct) must be present.

The form of the answer is given so any integrals should include d*x*'s and d*t*'s correctly placed

(b) Using the substitution

B1: States $\frac{\mathrm{d}u}{\mathrm{d}t} = \cos t$ or equivalent. It can be awarded for replacing the $\mathrm{d}t$ by $\frac{\mathrm{d}u}{\cos t}$

M1: Substitutes fully using $u = \sin t$ producing an integral just in terms of *u*. Accept $\cos^2 t = \pm 1 \pm \sin^2 t$

So award for the form $\pm k\int u^2(\pm 1 \pm u^2)\ \mathrm{d}u$

dM1: Multiplies out to form a polynomial expression of the form $\pm au^2 \pm bu^4$ and integrates each term with correct powers for their expression

ddM1: All previous method marks must have been scored in (b).
It is for using correct limits within a suitable expression
It is for substituting $\left[\frac{1}{2}, 0\right]$ into an acceptable expression and subtracting either way around.

Alternatively, it is for substituting $\left[\frac{\pi}{6}, 0\right]$ into an acceptable expression in *t* if *u* is replaced by $\sin t$

A1: $V = \frac{17\pi}{10}$ oe such as $V = \frac{51\pi}{30}$

(b) Otherwise

B1: Writes their $k\int \sin^2 t\cos^3 t\,\mathrm{d}t$ as $k\int \sin^2 t\left(1-\sin^2 t\right)\cos t\,\mathrm{d}t$

M1: Multiplies out into a form that can be integrated $\pm\ldots\sin^2 t\cos t \pm\ldots\sin^4 t\cos t$ allowing for $\cos^2 t = \pm 1 \pm \sin^2 t$

dM1: Correct integration. Look for the form $\ldots\sin^3 t \pm \ldots\sin^5 t$

ddM1: Dependent upon both previous M's in part (b).

Scored for substituting $\left[\frac{\pi}{6}, 0\right]$ into an acceptable expression in t

A1: $V = \frac{17\pi}{10}$ oe such as $V = \frac{51\pi}{30}$

Question Number	Scheme	Marks
7(a)	$\frac{1}{(4-x)(2-x)} = \frac{A}{(4-x)} + \frac{B}{(2-x)} \Rightarrow 1 \equiv A(2-x) + B(4-x) \Rightarrow A = \ldots \text{ or } B = \ldots$	M1
	$A = -\frac{1}{2}, B = \frac{1}{2}$ giving $\frac{-\frac{1}{2}}{(4-x)} + \frac{\frac{1}{2}}{(2-x)}$	A1
		[2]
(b)	$\frac{\mathrm{d}x}{\mathrm{d}t} = k(4-x)(2-x),\ t \geqslant 0 \Rightarrow \int \frac{1}{(4-x)(2-x)}\,\mathrm{d}x = \int k\,\mathrm{d}t$	
	$\frac{1}{2}\ln(4-x) - \frac{1}{2}\ln(2-x) = kt\ (+c)$	M1, A1
	$\{t=0, x=0 \Rightarrow\}\ \frac{1}{2}\ln 4 - \frac{1}{2}\ln 2 = 0 + c\ \left\{\Rightarrow c = \frac{1}{2}\ln 2\right\}$	M1
	$\frac{1}{2}\ln(4-x) - \frac{1}{2}\ln(2-x) = kt + \frac{1}{2}\ln 2 \Rightarrow \ln\left(\frac{4-x}{4-2x}\right) = 2kt$	
	$\frac{4-x}{4-2x} = \mathrm{e}^{2kt}$	M1
	$4-x = 4\mathrm{e}^{2kt} - 2x\mathrm{e}^{2kt} \Rightarrow 4 - 4\mathrm{e}^{2kt} = x - 2x\mathrm{e}^{2kt}$	
	$\Rightarrow 4 - 4\mathrm{e}^{2kt} = x(1 - 2\mathrm{e}^{2kt}) \Rightarrow x = \frac{4-4\mathrm{e}^{2kt}}{1-2\mathrm{e}^{2kt}}\ (*)$	dM1, A1*
		[6]
(c)	$1 = \frac{4-4\mathrm{e}^{0.2t}}{1-2\mathrm{e}^{0.2t}} \Rightarrow 2\mathrm{e}^{0.2t} = 3$	M1
	$\Rightarrow 0.2t = \ln\frac{3}{2} \Rightarrow t = \text{awrt } 2.03$	A1
		[2]
		10 marks

(a)

M1: For forming a correct identity leading to one value of A or B.

For example, $1 \equiv A(2-x) + B(4-x)$ from $\frac{1}{(4-x)(2-x)} = \frac{A}{(4-x)} + \frac{B}{(2-x)}$ and finds at least one of $A = \ldots$ or $B = \ldots$.

This would be implied using cover up rule and reaching one correct fraction

A1: $\frac{-\frac{1}{2}}{(4-x)} + \frac{\frac{1}{2}}{(2-x)}$ or any equivalent form. **It is not scored for just the values**

ISW after sight of a correct answer. It may be awarded in part (b)

(b)

M1: Integrates to the form $\pm\lambda\ln(4-x) \pm \mu\ln(2-x),\ \lambda \neq 0, \mu \neq 0$

Note that versions such as $\pm\lambda\ln(8-2x) \pm \mu\ln(4-2x),\ \lambda \neq 0, \mu \neq 0$ ARE correct