Question Number	Scheme	Marks
5.	One of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$	B1
	Two of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$	B1
	All three of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$	B1
Main	Full attempt to find $\frac{dV}{dt}$ E.g. $\frac{dV}{dt}=\frac{dV}{dx}\times\frac{dx}{dA}\times\frac{dA}{dt}=18\pi x^2\times\frac{1}{2\pi x}\times\frac{\pi}{20}$	M1
	Finds $\frac{dV}{dt}$ at $x=2\Rightarrow$ $\frac{dV}{dt}=18\pi 2^2\times\frac{1}{80}=\frac{9}{10}\pi$	dM1 A1 **(6 marks)**
	Note that the M1 may be found in two steps: E.g.I Finds $\frac{dx}{dt}$ from $\frac{dA}{dt}=\frac{dA}{dx}\times\frac{dx}{dt}$ followed by $\frac{dV}{dt}=\frac{dV}{dx}\times\frac{dx}{dt}$ E.g II Finds $\frac{dV}{dA}$ from $\frac{dV}{dx}=\frac{dV}{dA}\times\frac{dA}{dx}$ followed by $\frac{dV}{dt}=\frac{dV}{dA}\times\frac{dA}{dt}$	
Alt	$\frac{dA}{dt}=\frac{\pi}{20}$	B1
	$V=6\pi x^3, A=\pi x^2\Rightarrow V=6\pi\left(\frac{A}{\pi}\right)^{\frac{3}{2}}$ $\frac{dV}{dA}=9\left(\frac{A}{\pi}\right)^{\frac{1}{2}}$	B1, B1
	$\frac{dV}{dt}=\frac{dV}{dA}\times\frac{dA}{dt}\Rightarrow\frac{dV}{dt}=9\left(\frac{A}{\pi}\right)^{\frac{1}{2}}\times\frac{\pi}{20}$	M1
	$x=2\Rightarrow A=4\pi$ $\Rightarrow \left.\frac{dV}{dt}\right\|_{A=4\pi}=\frac{9}{10}\pi$	dM1A1 **(6 marks)**

Main method:

Condone the use of other letters such as *S* for *A* or *r* for *x*

Ignore any reference to units

The marks have now changed in this question to B1, B1, B1, M1, dM1, A1

B1: States or uses one of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$

B1: States or uses two of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$

B1: States or uses all three of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$

Note that the circumference of the circle is $2\pi x$. You should not be awarding B1 for sight of $2\pi x$ unless you can see it set equal to, or implied equal to $\frac{dA}{dx}$

M1: For a full attempt at finding $\frac{\mathrm{d}V}{\mathrm{d}t}$. There are many ways to do this including

- In one step: Uses $\frac{\mathrm{d}V}{\mathrm{d}t}=\frac{\mathrm{d}V}{\mathrm{d}x}\times\frac{\mathrm{d}x}{\mathrm{d}A}\times\frac{\mathrm{d}A}{\mathrm{d}t}$ with $\frac{\mathrm{d}A}{\mathrm{d}t}=\frac{\pi}{20}$, $\frac{\mathrm{d}A}{\mathrm{d}x}=px$ and $\frac{\mathrm{d}V}{\mathrm{d}x}=qx^2$
- In two steps: Finds $\frac{\mathrm{d}x}{\mathrm{d}t}$ from $\frac{\mathrm{d}A}{\mathrm{d}t}=\frac{\mathrm{d}A}{\mathrm{d}x}\times\frac{\mathrm{d}x}{\mathrm{d}t}$ with $\frac{\mathrm{d}A}{\mathrm{d}t}=\frac{\pi}{20}$ and $\frac{\mathrm{d}A}{\mathrm{d}x}=px$

  followed by finding $\frac{\mathrm{d}V}{\mathrm{d}t}$ from $\frac{\mathrm{d}V}{\mathrm{d}t}=\frac{\mathrm{d}V}{\mathrm{d}x}\times\frac{\mathrm{d}x}{\mathrm{d}t}$ with $\frac{\mathrm{d}V}{\mathrm{d}x}=qx^2$ and their $\frac{\mathrm{d}x}{\mathrm{d}t}$

Condone slips when rearranging the chain rules but they must at least be correct to start with.

Condone slips on the coefficients of x and x^2 of $\frac{\mathrm{d}A}{\mathrm{d}x}=px$ and $\frac{\mathrm{d}V}{\mathrm{d}x}=qx^2$ respectively

If they state the chain rule $\frac{\mathrm{d}A}{\mathrm{d}t}=\frac{\mathrm{d}A}{\mathrm{d}x}\times\frac{\mathrm{d}x}{\mathrm{d}t}$ then make an algebraic error they may be awarded this method mark

dM1: For a full attempt at finding the value of $\frac{\mathrm{d}V}{\mathrm{d}t}$ at $x=2$ It is dependent upon the previous M

A1: $\frac{9}{10}\pi$ or 0.9π or $\frac{18}{20}\pi$ ……or k =0.9 etc

Alt method: Solution obtained directly via $\frac{\mathrm{d}V}{\mathrm{d}A}$

B1: States or uses $\frac{\mathrm{d}A}{\mathrm{d}t}=\frac{\pi}{20}$

B1: Differentiates their $V=\alpha A^{\frac{3}{2}}\rightarrow\frac{\mathrm{d}V}{\mathrm{d}A}=rA^{\frac{1}{2}}$

B1: A correct $\frac{\mathrm{d}V}{\mathrm{d}A}=9\left(\frac{A}{\pi}\right)^{\frac{1}{2}}$ o.e such as $\frac{\mathrm{d}V}{\mathrm{d}A}=\frac{9}{\sqrt{\pi}}A^{\frac{1}{2}}$

M1: For a full attempt at finding $\frac{\mathrm{d}V}{\mathrm{d}t}$ using $\frac{\mathrm{d}V}{\mathrm{d}t}=\frac{\mathrm{d}V}{\mathrm{d}A}\times\frac{\mathrm{d}A}{\mathrm{d}t}$.

To award this, candidates must be using $\frac{\mathrm{d}A}{\mathrm{d}t}=\frac{\pi}{20}$ and $\frac{\mathrm{d}V}{\mathrm{d}A}=rA^{\frac{1}{2}}$

dM1: Finds the value of $\frac{\mathrm{d}V}{\mathrm{d}t}$ at $A=4\pi$ It is dependent upon the previous M

A1: $\frac{9}{10}\pi$ or 0.9π or $\frac{18}{20}\pi$ ……or k =0.9 etc

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