Question	Scheme	Marks
2(a)	$\left(\dfrac{1}{(1+3x)(1-x)}=\dfrac{A}{1+3x}+\dfrac{B}{1-x}\Rightarrow\right) 1=A(1-x)+B(1+3x)$	B1
	when $x=1 \Rightarrow 1=4B\Rightarrow B=...$ or when $x=-\dfrac{1}{3} \Rightarrow 1=\dfrac{4}{3}A\Rightarrow A=...$	M1
	$\dfrac{3}{4(1+3x)}+\dfrac{1}{4(1-x)}$	A1
		(3)
(b)	$\int \cot y \, \mathrm{d}y=\int ... \, \mathrm{d}x \Rightarrow "\ln\sin y"=\int ... \, \mathrm{d}x$	M1
	$...=\int\left("\dfrac{3}{4(1+3x)}"+"\dfrac{1}{4(1-x)}"\right)\mathrm{d}x=...\ln(1+3x)\pm...\ln(1-x) \ \ (+c)$	M1
	$\ln\sin y=\dfrac{1}{4}\ln(1+3x)-\dfrac{1}{4}\ln(1-x) \ \ (+c)$ oe	A1ft
	$\ln\sin\left(\dfrac{\pi}{2}\right)=\dfrac{1}{4}\ln\left(1+3\times\dfrac{1}{2}\right)-\dfrac{1}{4}\ln\left(1-\dfrac{1}{2}\right)+c\Rightarrow c=...\left(=-\dfrac{1}{4}\ln 5\right)$	dM1
	$k\ln\sin y=m\ln(...)\Rightarrow \sin^k y=...^m$ or $k\ln\sin y=...\Rightarrow \sin^k y=\exp(...)$	M1
	$\sin^4 y=\dfrac{1+3x}{5(1-x)}$	A1
		(6)
		(9 marks)

Notes

(a)

B1: For a correct suitable identity without fractions, such as $1=A(1-x)+B(1+3x)$, seen or implied.

M1: Attempts to find one of the constants by either substitution or equating coefficients. May be implied by a correct value for *A* or *B* via cover up rule.

A1: $\dfrac{3}{4(1+3x)}+\dfrac{1}{4(1-x)}$ oe allow values for *A* and *B* to be stated following a correct partial fraction form, or if correct partial fractions see in (b).

(b)

M1: Attempts to separate variables to form $\cot y\dfrac{\mathrm{d}y}{\mathrm{d}x}=\mathrm{g}(x)$ (oe for cot *y*) and integrate $\cot y$. Accept any changed function for the attempt but must be attempting to integrate cot *y* (oe).

M1: Attempts to integrate their partial fractions from (a) so award for $\dfrac{...}{(1+3x)}\rightarrow ...\ln(1+3x)$ or $...\ln(4+12x)$

and $\dfrac{...}{(1-x)}\rightarrow ...\ln(1-x)$ or $...\ln(4-4x)$ oe

A1ft: Correct expression (any equivalent) (both sides). Follow through on their constants for the partial fractions. Condone the absence of the constant of integration.

dM1: Depends on second M, and must have attempted to integrate both sides. Uses the initial conditions in an equation with a constant of integration. May integrate between limits to achieve this. (Accept if a value for *c* cannot be reached from their equation.)

M1: Attempts to rearrange their equation by correctly using log work to reach the required form $\sin^n y=\mathrm{f}(x)$. Must have had *k*ln sin *y* = … (*k* may be 1). Not dependent - may be gained before finding the constant if ln *A* is used, and allow if the constant is missing.

A1: $\sin^4 y=\dfrac{1+3x}{5(1-x)}$ (oe in correct form)

Question	Scheme	Marks
3(a)	$\frac{dA}{dt} = -0.5$	B1
	$A = \pi x^2 \Rightarrow \frac{dA}{dx} = 2\pi x$	B1
	$\frac{dx}{dt} = \frac{dA}{dt} \div \frac{dA}{dx} = \frac{"-0.5"}{"2\pi x"} \quad \left(= \frac{-1}{4\pi x}\right)$	M1
	$\frac{dx}{dt} = -0.011368...$	A1cso
		(4)
(b)	$V = \pi x^2 (3x) = 3\pi x^3$	B1
	$\frac{dV}{dx} = 9\pi x^2$	B1ft
	$\frac{dV}{dt} = \frac{dV}{dx} \times \frac{dx}{dt} = 9\pi x^2 \times "-\frac{1}{4\pi x}" \ \left(= -2.25x\right)$	M1
	$\left(\frac{dV}{dt} =\right) -9 \Rightarrow$ (Rate of decrease $=$) $9 \ \left(\text{mm}^3\ \text{s}^{-1}\right)$	A1
		(4)
		(8 marks)

Notes

(a)

B1: $\frac{dA}{dt} = -0.5$ seen or implied from working

B1: $\frac{dA}{dx} = 2\pi x$ seen or implied from working. Must be in terms of x, but allow recovery if in terms of r and later work uses $r = 7$ to achieve a solution.

M1: Attempts to use an appropriate chain rule with their $\frac{dA}{dt}$ and $\frac{dA}{dx}$ e.g. $\frac{dx}{dt} = \frac{dA}{dt} \div \frac{dA}{dx} = ...$

A1: awrt -0.0114 or $-\frac{1}{28\pi}$ cso (must have the negative sign)

(b)

B1: $V = \pi x^2 (3x)$ or $V = 3\pi x^3$

B1ft: $\frac{dV}{dx} = 9\pi x^2$ or ft from their equation for V in one variable

M1: Their $\frac{dV}{dx} \times$ their $\frac{dx}{dt}$. Note the $\frac{dx}{dt}$ must be in terms of x or with $x = 4$ substituted first, M0 if they use their answer to (a).

A1: (Rate of decrease =) $9 \ \left(\text{mm}^3\ \text{s}^{-1}\right)$ (with or without the negative sign). May be scored following $\frac{dA}{dt} = 0.5$ in part (a)