Question Number	Scheme	Marks
5.	States or implies Volume = $\displaystyle\int_{\frac{1}{\sqrt{2}}}^{k}\pi\left(\frac{12\sqrt{x}}{(2x^2+3)^{1.5}}\right)^2\mathrm{d}x$	B1
	Attempts $\displaystyle\int\left(\frac{12\sqrt{x}}{(2x^2+3)^{1.5}}\right)^2\mathrm{d}x=\int\frac{144x}{(2x^2+3)^3}\mathrm{d}x=-18(2x^2+3)^{-2}$	M1A1
	Sets $\quad -\dfrac{18\pi}{(2k^2+3)^2}+\dfrac{18\pi}{(2\times\frac{1}{2}+3)^2}=\dfrac{713}{648}\pi$	M1
	$\Rightarrow -\dfrac{18}{(2k^2+3)^2}+\dfrac{9}{8}=\dfrac{713}{648}\Rightarrow(2k^2+3)^2=729\Rightarrow k^2=\ldots$	ddM1
	$k=2\sqrt{3}$	A1
		(6 marks)

B1: States or implies Volume = $\displaystyle\int_{\frac{1}{\sqrt{2}}}^{k}\pi\left(\frac{12\sqrt{x}}{(2x^2+3)^{1.5}}\right)^2\mathrm{d}x$ o.e. including limits and π.

You can condone a missing dx and the limits the wrong way around.

You may not see the limits until the integration has been attempted which is fine.

M1: Attempts $\displaystyle\int\left(\frac{\sqrt{x}}{(2x^2+3)^{1.5}}\right)^2\mathrm{d}x$ to achieve $A(2x^2+3)^{-2}$ o.e.

With substitution of $u=2x^2+3$ look for Au^{-2}

A1: Correct integration of $\displaystyle\int\left(\frac{12\sqrt{x}}{(2x^2+3)^{1.5}}\right)^2\mathrm{d}x$ to $-18(2x^2+3)^{-2}$ or $-18u^{-2}$ which may be left unsimplified.

Note that this can be scored with or without the π and may even have an incorrect coefficient of 2π

M1: Uses the limits (subtracts either way around) within their attempted integration of y^2 NOT y and sets equal to $\frac{713}{648}\pi$. Condone poor attempts at integrating the y^2 here.

Note that if they change limits to u where $u=2x^2+3$ look for limits of $2k^2+3$ and 4

ddM1: Dependent upon both previous M's. It is for proceeding to

either $(2k^2+3)^{\pm2}=B$ where $B>0$ leading to a value for k^2 or k

or setting up a quadratic equation in k^2 leading to a value for k^2 or k

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FYI

$$k^4+3k^2-180=0\Rightarrow\left(k^2-12\right)\left(k^2+15\right)=0\Rightarrow k^2=12$$

A1: $k=2\sqrt{3}$ or exact equivalent such as $\sqrt{12}$ Condone if $k=\pm2\sqrt{3}$ o.e.

Question Number	Scheme	Marks
6 (a)	For correct parameter $t=\frac{\pi}{4}$ or x coordinate at P $x=4$	B1
	$\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{\mathrm{d}y/\mathrm{d}t}{\mathrm{d}x/\mathrm{d}t}=\frac{-4\sin 2t}{3\sec^2 t}$	M1 A1
	Equation of tangent $y-0=-\frac{2}{3}\left(x-4\right)\Rightarrow y=-\frac{2}{3}x+\frac{8}{3}$	dM1 A1
		(5)
(b)	$k=1-\sqrt{3}$	B1
		(1)
(c)	$-1,,\ \mathrm{f}\ ,,\ 2$	M1 A1
		(2)
		(8 marks)

(a)

B1: Correct parameter or x coordinate at P.

The correct x coordinate $x=4$ (can even be scored following $x=45°$)

M1: Attempts to find $\frac{\mathrm{d}y}{\mathrm{d}x}$ using $\frac{\mathrm{d}y/\mathrm{d}t}{\mathrm{d}x/\mathrm{d}t}$. Condone poor differentiation.

A1: Correct $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-4\sin 2t}{3\sec^2 t}$. You may see other forms for this following use of identities.

If you see $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-4\sin 2t}{3\sec^2 \underline{x}}$ then only allow if they subsequently use this as $\frac{\mathrm{d}y}{\mathrm{d}x}=\frac{-4\sin 2t}{3\sec^2 t}$

Other possible correct gradients are $\frac{-8\sin t\cos t}{3\sec^2 t}$ and $\frac{-8\sin t\cos^3 t}{3}$

ISW after you see a correct answer. Quite often we see candidates incorrectly adapting a correct answer.

It is also possible for candidates to find $\frac{\mathrm{d}y}{\mathrm{d}t}$ at $t="\frac{\pi}{4}"$, $\frac{\mathrm{d}x}{\mathrm{d}t}$ at $t="\frac{\pi}{4}"$ and divide the two values.

dM1: Attempts to find the equation of the tangent at $t=\frac{\pi}{4}$

It is dependent upon the previous M and use of $\left(4,0\right)$ and $t=\frac{\pi}{4}$

Allow substitution into their adapted $\frac{\mathrm{d}y}{\mathrm{d}x}$

A1: $y=-\frac{2}{3}x+\frac{8}{3}$

(b)

B1: $k=1-\sqrt{3}$

(c)

M1: Either end correct. Allow strict inequalities here. E.g f < 2 scores M1 but f > 2 is M0

A1: $-1,,\ \mathrm{f}\ ,,\ 2$ o.e such as $\left[-1,2\right]$ and $-1,,\ y\ ,,\ 2$