Question Number	Scheme	Marks
8(a)	$\int x\cos 2x\,\mathrm{d}x = \frac{1}{2}x\sin 2x - \int \frac{1}{2}\sin 2x\,\mathrm{d}x$	M1A1
	$= \frac{1}{2}x\sin 2x + \frac{1}{4}\cos 2x + c$	A1
		(3)
(b)	$V = (\pi)\int (4x+3\cos 2x)^2\ \mathrm{d}x$ $V = (\pi)\int (16x^2 + 24x\cos 2x + 9\cos^2 2x)\mathrm{d}x$	M1
	$\int 24x\cos 2x\,\mathrm{d}x = 12x\sin 2x + 6\cos 2x(+c)$	M1
	$\int 9\cos^2 2x\,\mathrm{d}x = \frac{9}{2}\int (1+\cos 4x)\mathrm{d}x$	M1
	$\left[(\pi)\int (16x^2 + 24x\cos 2x + 9\cos^2 2x)\mathrm{d}x\right]$ $= (\pi)\left(\frac{16x^3}{3} + 12x\sin 2x + 6\cos 2x + \frac{9x}{2} + \frac{9}{8}\sin 4x(+c)\right)$	A1
	$V = \pi\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} (4x+3\cos 2x)^2\,\mathrm{d}x = \pi\left(\frac{16\pi^3}{24} + 0 - 6 + \frac{9\pi}{4} + 0 - \left(\frac{16\pi^3}{192} + 3\pi + 0 + \frac{9\pi}{8} + 0\right)\right)$	M1
	$\pi\left(\frac{7\pi^3}{12} - \frac{15\pi}{8} - 6\right)$	A1
		(6)
		Total 9

Notes

(a)

M1: Applies integration by parts to obtain the form $...x\sin 2x \pm ...\int \sin 2x\,\mathrm{d}x$

A1: Correct expression

A1: Completes the integration to obtain the correct answer including + *c*

If the "DI" method is used:

x	$\cos 2x$
1	$\frac{1}{2}\sin 2x$
0	$-\frac{1}{4}\cos 2x$

Award M1 for reaching the correct form of the answer e.g. $...x\sin 2x+...\cos 2x$ with A1 implied by their table and A1 as above.

(b)

Condone the missing π from $\pi\int ...$ for the 4 marks.

M1: Attempts $\int \left(4x+3\cos 2x\right)^2 \,\mathrm{d}x$ and multiplies out the bracket with 2 out of 3 terms correct.

M1: Uses part (a) to attempt their $\int 24x\cos 2x\,\mathrm{d}x$ provided part (a) is in the form $...x\sin 2x\pm...\cos 2x$

An attempt is defined as using their part (a) correctly here with their '24'

M1: Attempts $\int \cos^2 2x\,\mathrm{d}x$ using the correct identity $\cos 4x=2\cos^2 2x-1$ and reaches

$$\int \cos^2 2x\,\mathrm{d}x=...x+...\sin 4x\left(+c\right)$$

A1: Fully correct integration in any form.
M1: Complete method to find the volume with π and the given limits [accept substituted either way around] using their integral which must include at least two trigonometrical terms.
A1: Correct volume in the required form.

Question Number	Scheme	Marks
9(a)	$\frac{\mathrm{d}\theta}{\mathrm{d}t}=-k(\theta+15)\Rightarrow\int\frac{\mathrm{d}\theta}{\theta+15}=\int-k\,\mathrm{d}t$ **OR** $\frac{\mathrm{d}t}{\mathrm{d}\theta}=\frac{1}{-k(\theta+15)}$ $\Rightarrow\ln(\theta+15)=-kt(+c)$ o.e. $\Rightarrow t=-\frac{1}{k}\ln(\theta+15)+c$	M1A1
	$t=0,\theta=21\Rightarrow c=.....(\text{e.g.},c=\ln 36)$	M1
	$\ln(\theta+15)=-kt+\ln 36$ $\Rightarrow\theta+15=\mathrm{e}^{-kt+\ln 36}$ **OR** $\ln(\theta+15)=-kt+\ln 36$ $\Rightarrow\left[\ln(\theta+15)-\ln 36=-kt\right]$ $\Rightarrow\ln\left(\frac{\theta+15}{36}\right)=-kt\Rightarrow\theta=36\mathrm{e}^{-kt}-15$	M1
	$\theta=36\mathrm{e}^{-kt}-15$	A1
		(5)
(b)	$12.9=36\mathrm{e}^{-20k}-15\Rightarrow\mathrm{e}^{-20k}=\frac{31}{40}\Rightarrow-20k=\ln\frac{31}{40}\Rightarrow k=...$	M1
	$k=0.0127$	A1
		(2)
(c)	$t=60\Rightarrow\theta='36'\mathrm{e}^{-60\times'0.0127'}-'15'$	M1
	$=1.8\left(^{\circ}\mathrm{C}\right)$	A1
		(2)
		Total 9

Notes

(a)

M1: Separates the variables **and** integrates to obtain $...\ln(\theta+15)=...kt(+c)$ (or equivalent) with or without a constant of integration.

A1: Correct equation with or without a constant of integration.

If they do not have a constant of integration the following 3 marks are not available

M1: States or uses $t=0$ and $\theta=21$ to find a value for "c" . Do not be concerned by the rearrangement as long as a value of c is found.

M1: Rearranges using correct application of log processing to make θ the subject

A1: Correct equation

(b)

M1: Sets their θ = 12.9, substitutes t = 20 into their expression which is minimally of the form $\theta=\alpha\mathrm{e}^{-kt}\pm\beta$ where α can equal 1 and rearranges **using correct explicit log work** to find k.

For the award of this mark their $'\frac{31}{40}'$ must be a positive number.

A1: Awrt 0.0127

(c)

M1: Substitutes t = 60 and their k into their $\theta=36\mathrm{e}^{-kt}-15$ which must be minimally of the form $\theta=\alpha\mathrm{e}^{-kt}-\beta$

Unless the final answer is correct coming from a correct equation, substitution of 60 must be explicit.