Question	Scheme	Marks
7(a)	$u = 4x + 2\sin 2x \Rightarrow \dfrac{\mathrm{d}u}{\mathrm{d}x} = 4 + 4\cos 2x$ oe	**M1 A1**
	$\dfrac{\mathrm{d}u}{\mathrm{d}x} = 4 + 4\cos 2x = 8\cos^2 x \Rightarrow \int_{(0)}^{\left(\frac{\pi}{2}\right)} \mathrm{e}^{4x+2\sin 2x}\cos^2 x\,\mathrm{d}x = \int_{(0)}^{(2\pi)} \dfrac{\mathrm{e}^u}{8}\,\mathrm{d}u$	**M1**
	$= \left[\text{"}\dfrac{1}{8}\text{"}\mathrm{e}^u\right]_0^{2\pi}$ or $\left[\text{"}\dfrac{1}{8}\text{"}\mathrm{e}^{4x+2\sin 2x}\right]_0^{\frac{\pi}{2}}$	**A1ft**
Alt by inspection for first 4 marks	$\int \mathrm{e}^{4x+2\sin 2x}\cos^2 x\,\mathrm{d}x = \int \mathrm{e}^{4x+2\sin 2x} \times \dfrac{1}{2}\left(1 \pm \cos 2x\right)\mathrm{d}x$	**(M1 A1)**
	$= k\mathrm{e}^{4x+2\sin 2x}$; $= \left[\text{"}\dfrac{1}{8}\text{"}\mathrm{e}^{4x+2\sin 2x}\right]_0^{\frac{\pi}{2}}$	**(M1; A1ft)**
	$= \left[\dfrac{1}{8}\mathrm{e}^u\right]_0^{2\pi}$ or $\left[\dfrac{1}{8}\mathrm{e}^{4x+2\sin 2x}\right]_0^{\frac{\pi}{2}} = \dfrac{1}{8}\left(\mathrm{e}^{2\pi} - 1\right)$*	**A1*cso**
		(5)
(b)	$V\left[= \pi\int_0^{\frac{\pi}{2}} y^2\,\mathrm{d}x = \pi\int_0^{\frac{\pi}{2}} \left(6\mathrm{e}^{2x+\sin 2x}\cos x\right)^2\,\mathrm{d}x\right] = 36\pi\int_0^{\frac{\pi}{2}} \mathrm{e}^{4x+2\sin 2x}\cos^2 x\,\mathrm{d}x$	**B1**
	$K\int_0^{\frac{\pi}{2}} \mathrm{e}^{4x+2\sin 2x}\cos^2 x\,\mathrm{d}x = \dfrac{K}{8}\left(\mathrm{e}^{2\pi} - 1\right)$	**M1**
	$= \dfrac{9\pi}{2}\left(\mathrm{e}^{2\pi} - 1\right)$	**A1**
		(3)
		(8 marks)

Notes:

(a)

M1: Attempts the derivative of *u*. Look for $\sin 2x \to ...\cos 2x$ May apply double angle formula first, look for $u = 4x + k\sin x\cos x \to \dfrac{\mathrm{d}u}{\mathrm{d}x} = \left(4 + \right)k\left(\cos^2 x - \sin^2 x\right)$ oe. Form should be correct but there may be sign errors.

A1: Correct derivative (any form).

M1: Applies a double angle formula – must be seen – and carries out the full substitution to get an integral in terms of *u*. Must include an attempt to replace d*x*. Do not be concerned with the limits for this mark.

A1ft: Integrates to achieve the correct form with their constant with correct limits assigned (either in *u* or reverted in *x*)– must have scored the M1.

A1*cso: Correct answer from fully correct working. Must have identified **correct** limits in terms of *u* or have reverted back to *x* with the original limits before giving the final answer.

Alt for first 4 marks, by inspection:

M1: Applies double angle formula for $\cos^2 x$ (allowing for sign error) in the integrand in the form shown – must be this form to be able to apply recognition.

A1: Correct expression for the integrand in this form.

M1: Integrates, achieving the correct form.

A1ft: Achieves the correct integral from correct work with correct limits assigned – the double angle formula must have been correct (follow through if e.g they lose the ½ from the double angle formula before integrating).

(b)

B1: Applies correct volume formula with π seen somewhere in the answer and squares correctly to achieve the correct y^2. The limits may be missing for this mark. May be implied by the correct answer.

M1: Makes the connection with part (a) and multiplies the answer to (a) by their constant formed from their attempt at y^2. The use of (a) may be via reuse of the substitution. May be implied by an expression $M\left(\mathrm{e}^{2\pi}-1\right)$, $M \neq \frac{1}{8}$ if no incorrect working is shown for this (but a clearly incorrect method seen is M0).

A1: cao. As shown or $\frac{9\pi}{2}\mathrm{e}^{2\pi} - \frac{9\pi}{2}$

Question	Scheme	Marks
8	$y = 2x + x^3 + \cos x$	
	Assume (there is a stationary point so) $\frac{dy}{dx} = 0$ for some value of x	**B1**
	So for this x $\frac{dy}{dx} = 2 + 3x^2 - \sin x$	**M1**
	$\frac{dy}{dx} = 0 \Rightarrow \sin x = 3x^2 + 2 \ldots 2$	**dM1**
	This is a contradiction as $\lvert \sin x \rvert$,, 1 for all x, hence the assumption is false and so the function has no stationary points.	**A1cso**
		(4)
		(4 marks)

Notes:

B1: For a clear, suitable assumption with reference to $\frac{dy}{dx} = 0$ or implication that it means $\frac{dy}{dx} = 0$ at some point in their proof. Need not mention "for some x", but stating "for all x" is B0. Accept just "Assume $\frac{dy}{dx} = 0$"

M1: Attempts the derivative achieving $2 + 3x^2 \pm \sin x$

dM1: Makes progress with a correct method leading to a contradiction. E.g. set their derivative equal to 0, makes sin x the subject and deduces greater than or equal to 2. Other methods are possible, e.g. states $x^2 \geq 0$ and $\sin x \leq 1$ and deduces $2 + 3x^2 - \sin x \geq 1$ (hence cannot be zero). It must be clear what the contradiction will be but allow if there are some inaccuracies in details e.g. condone if a strict inequality is used for this mark. There must be reference to both $(3)x^2 \ldots 0$ and the range of $\sin x$ in some way.

Do not accept "this equation has no solutions" without proof as to why there can be no solutions.

Note: A sketch is not a proof. An algebraic approach is required, but accept verbal arguments (e.g. stating "the minimum of $2+3x^2$ is 2" and "sin x cannot exceed one" etc), which may accompany a sketch.

A1cso: Fully correct proof, with derivative correct and contradiction made clear and conclusion drawn referring back to no stationary points. All necessary details must have been given. Condone cases where strict inequalities have been given instead of unstrict ones.