Question	Scheme	Marks
4(a)	$(l=)\sqrt{25+r^2}$	**B1**
		(1)
(b)	$\left(S=\pi r^2+\right)\pi r\sqrt{25+r^2} \Rightarrow \left(\frac{\mathrm{d}S}{\mathrm{d}r}=2\pi r+\right)\underline{\pi\sqrt{25+r^2}+\pi r.\frac{1}{2}\left(25+r^2\right)^{-\frac{1}{2}}.2r}$ Or $\left(S=\pi r^2+\right)\pi\sqrt{25r^2+r^4} \rightarrow \left(\frac{\mathrm{d}S}{\mathrm{d}r}=2\pi r+\right)\underline{\pi.\frac{1}{2}\left(25r^2+r^4\right)^{-\frac{1}{2}}\times\left(50r+4r^3\right)}$	**M1** **A1**
	$\left(S=\pi\left(l^2-25\right)\right)+\pi l\sqrt{l^2-25} \Rightarrow \left(\frac{\mathrm{d}S}{\mathrm{d}l}=2\pi l+\right)\underline{\pi\sqrt{l^2-25}+\pi l.\frac{1}{2}\left(l^2-25\right)^{-\frac{1}{2}}.2l}$	**(M1** **A1)**
	$\frac{\mathrm{d}S}{\mathrm{d}t}=\frac{\mathrm{d}S}{\mathrm{d}r}\times\frac{\mathrm{d}r}{\mathrm{d}t}=..\times 3$	**M1**
	$=81.5\left(\mathrm{cm}^2/\mathrm{min}\right)$	**A1**
		(4)
		(5 marks)

Notes:

(a)

B1: Correct expression. Accept $(l=)\sqrt{5^2+r^2}$ and isw.

(b)

M1: Differentiates their surface area with use of the product and chain rules on a term of the form $Kr\sqrt{\pm L\pm r^2}$ - look the form (oe) $P\sqrt{"25"+r^2}+Qr^2\left("25"+r^2\right)^{-\frac{1}{2}}$. The base area may be missing for this mark. Alternatively they may work in terms of *l* and the scheme marks equivalently – see box in main scheme for the derivative in this case.

Alt: Taking *r* inside the square root look for $K\sqrt{25r^2+r^4} \rightarrow K.\frac{1}{2}\left(25r^2+r^4\right)^{-\frac{1}{2}}\times\left(\alpha r+\beta r^3\right)$

A1: Correct differentiation for the curved surface area. Need not be simplified.

Alt: With *r* inside the square root $\pi\sqrt{25r^2+r^4} \rightarrow \pi.\frac{1}{2}\left(25r^2+r^4\right)^{-\frac{1}{2}}\times\left(50r+4r^3\right)$

M1: Applies the chain rule correctly with $\frac{\mathrm{d}r}{\mathrm{d}t}=3$ and their expression for $\frac{\mathrm{d}S}{\mathrm{d}r}$ (which may be in terms of *r* and *l*) or their value for $\frac{\mathrm{d}S}{\mathrm{d}r}$ at *r* = 1.5 if they find this first. This mark is for the chain rule being applied, so their previous expressions need not have been correct. If they are working in terms of *l* they will need to use $\frac{\mathrm{d}S}{\mathrm{d}t}=\frac{\mathrm{d}S}{\mathrm{d}l}\times\frac{\mathrm{d}l}{\mathrm{d}r}\times\frac{\mathrm{d}r}{\mathrm{d}t}$.

A1: For awrt 81.5, do not need the units. Accept $\left(9+\frac{177\sqrt{109}}{109}\right)\pi$ oe

(FYI it is 81.535404…)

(b) **Alt 1**	$\frac{dr}{dt}=3\Rightarrow r=3t(+c)\Rightarrow S=9\pi\left(t(+c')\right)^2+3\pi\left(t(+c')\right)\sqrt{25+9\left(t(+c')\right)^2}$ $\Rightarrow\frac{dS}{dt}=18\pi(t)+\underline{3\pi\sqrt{25+9(t)^2}+3\pi(t).\frac{1}{2}\left(25+9(t)^2\right)^{-\frac{1}{2}}.18(t)}$ Or $\frac{dS}{dt}=18\pi(t)+\underline{3\pi.\frac{1}{2}\left(25(t)^2+9(t)^4\right)^{-\frac{1}{2}}\times\left(50(t)+36(t)^3\right)}$ where (t) may be $\left(t+(c')\right)$ throughout)	**M1** **A1**
	$r=1.5\Rightarrow t(+c')=0.5\Rightarrow\frac{dS}{dt}=...$	**M1**
	$=81.5\left(\text{cm}^2/\text{min}\right)$	**A1**
		(4)

Notes:

Alt 1 (b)

M1: Uses $\frac{dr}{dt}=3$ and integrates to $r=3t+c$, where c may be omitted (without loss of generality the time frame can be set to $t = 0$ when $r = 0$), and substitutes into the surface area formula, with their l to form an expression of the correct form and proceeds to differentiate and find $\frac{dS}{dt}$ achieving a suitable form for the curved surface area part (as per main scheme, the only difference is the constant multiples).

A1: Correct differentiation for the curved surface area. Need not be simplified. Accept equivalents and may be working to t or $t + c$ throughout.

M1: Finds t (+ c) when $r = 1.5$ and substitutes into their $\frac{dS}{dt}$.

A1: For awrt 81.5, or as per main scheme.

(b) **Alt 2**	$\frac{dl}{dt}=\frac{dl}{dr}\frac{dr}{dt}=3\times\frac{1}{2}(r^2+25)^{-\frac{1}{2}}\times 2r$	**M1** **A1**
	$S=\pi r^2+\pi rl\Rightarrow\frac{dS}{dt}=2\pi r\frac{dr}{dt}+\pi\frac{dr}{dt}l+\pi r\frac{dl}{dt}$	**M1**
	$=81.5\left(\text{cm}^2/\text{min}\right)$	**A1**
		(4)

Notes:

Alt 2 (b)

M1: Uses the chain rule and their expression from (a) to find $\frac{dl}{dt}$ and uses $\frac{dr}{dt}=3$.

A1: Correct derivative.

M1: Uses implicit differentiation to find $\frac{\mathrm{d}S}{\mathrm{d}t}$ in terms of $\frac{\mathrm{d}r}{\mathrm{d}t}$ and $\frac{\mathrm{d}l}{\mathrm{d}t}$.

A1: As main scheme.

Question	Scheme	Marks
5(a)	$\int x^2 \cos 2x \,\mathrm{d}x = x^2.\frac{1}{2}\sin 2x - \int 2x.\frac{1}{2}\sin 2x \,\mathrm{d}x$	**M1 A1**
	$= x^2.\frac{1}{2}\sin 2x - \left(-\frac{1}{2}x\cos 2x - \int -\frac{1}{2}\cos 2x \,\mathrm{d}x\right)$	**M1**
	$= \frac{1}{2}x^2 \sin 2x + \frac{1}{2}x\cos 2x - \frac{1}{4}\sin 2x \ (+c)$	**A1**
		(4)
(b)	$\frac{\mathrm{d}y}{\mathrm{d}t} = \frac{t^2\cos^2 t}{y^2} \Rightarrow$ e.g. $\int y^2 \frac{\mathrm{d}y}{\mathrm{d}t}\mathrm{d}t$ or $\int y^2 \,\mathrm{d}y = \int t^2\cos^2 t \,\mathrm{d}t$	**B1**
	$\Rightarrow \frac{y^3}{3} = \ldots \quad ; \quad \ldots = \frac{1}{2}\int t^2 + t^2\cos 2t \,\mathrm{d}t$	**M1 ; M1**
	$\ldots = \frac{1}{6}t^3 + \frac{1}{2}\left(\frac{1}{2}t^2\sin 2t + \frac{1}{2}t\cos 2t - \frac{1}{4}\sin 2t\right) \quad (+c)$	**M1**
	$\Rightarrow y^3 = \frac{1}{2}t^3 + \frac{3}{4}t^2\sin 2t + \frac{3}{4}t\cos 2t - \frac{3}{8}\sin 2t + c$	**A1ft**
		(5)
		(9 marks)

Notes:

(a)

M1: Attempts parts in the correct direction – look for $Ax^2\sin 2x \pm \int Bx\sin 2x \,\mathrm{d}x$ unless they explicitly state an incorrect formula (in which case it is M0).

A1: Correct first application of parts.

M1: Attempts parts again in the same direction. $\int x\sin 2x \,\mathrm{d}x \to Kx\cos 2x \pm L\int \cos 2x \,\mathrm{d}x$

A1: Correct answer with or without constant of integration. ISW after a correct answer.

(b)

Note: accept use of x in place of t (or even mixed x's and t's) for the method marks if the intention is clear, but the final A mark needs to be correct in terms of t.

B1: Correct separation of variables with indication to integrate (e.g. statement as shown in scheme, or an attempt to integrate one side).

M1: For $y^n \to \ldots y^{n+1}$ on the left hand side.