Question	Scheme	Marks
5(a)	$x=(2t+3)^{\frac{3}{2}} \qquad y=\frac{3}{2}t^2+3t+6 \qquad -\frac{3}{2}\text{„ } t \text{„ } 3$	
	$\frac{\mathrm{d}x}{\mathrm{d}t}=\frac{3}{2}(2t+3)^{\frac{1}{2}}\times 2 \qquad \frac{\mathrm{d}y}{\mathrm{d}t}=3t+3$	**M1A1**
	$\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2+\left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^2=9(2t+3)+(3t+3)^2=\ldots$	**M1**
	$\left[=9(t^2+4t+4)\right]=9(t+2)^2$	**A1**
		(4)
(b)	Arc length $=\int_{-\frac{3}{2}}^{3}\sqrt{\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2+\left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^2}\,\mathrm{d}t=3\int_{-\frac{3}{2}}^{3}t+2\,\mathrm{d}t=3\left[\frac{t^2}{2}+2t\right]_{-\frac{3}{2}}^{3}$	**M1**
	$=3\left[\left(\frac{9}{2}+6\right)-\left(\frac{9}{8}-3\right)\right]=\ldots$	**M1**
	$=\frac{297}{8}$	**A1**
		(3)
(c)	Surface area $=2\pi\int_{-\frac{3}{2}}^{3}y\sqrt{\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2+\left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^2}\,(\mathrm{d}t)=6\pi\int_{-\frac{3}{2}}^{3}\left(\frac{3}{2}t^2+3t+6\right)(t+2)(\,\mathrm{d}t)$	**B1ft**
	$=6\pi\int_{-\frac{3}{2}}^{3}\frac{3}{2}t^3+6t^2+12t+12\,\mathrm{d}t=6\pi\left[\frac{3}{8}t^4+2t^3+6t^2+12t\right]_{-\frac{3}{2}}^{3}$	**M1**
	$=6\pi\left[\left(\frac{3}{8}3^4+2\times 3^3+6\times 3^2+12\times 3\right)-\left(\frac{3}{8}\left(\frac{81}{16}\right)+2\left(-\frac{27}{8}\right)+6\left(\frac{9}{4}\right)+12\left(-\frac{3}{2}\right)\right)\right]$ $=6\pi\left(\frac{1395}{8}-\frac{-1197}{128}\right)=\ldots$	**dM1**
	$=\frac{70551\pi}{64}$	**A1**
		(4)
		(11 marks)

Notes

(a)

M1: Attempts both derivatives with correct form for each, $\frac{\mathrm{d}x}{\mathrm{d}t}=A(2t+3)^{\frac{1}{2}}$, $\frac{\mathrm{d}y}{\mathrm{d}t}=Bt+3$.

A1: Both correct.

M1: Squares and adds their two derivatives and proceeds to simplify to a 3TQ

A1: Correct answer obtained with no incorrect working seen. Allow $a = 9$ stated as answer if they reach at least $9(t^2+4t+4)$ but do not show the factorisation.

(b)

M1: Applies the arc length formula and integrates the square root of their answer to (a) achieving a quadratic answer. (Allow if their a is not square rooted.) Limits not needed for this mark. Note they may integrate via reverse chain rule to $A(t+2)^2$ (which is equivalent).

M1: Applies the correct limits to their integral, which must have been from an attempt at the correct formula, but allow if $a(t+2)^2$ was used following a stated correct formula. Must have seen an increase in power in at least one term in the linear function – or quadratic if $a(t+2)^2$ was used per note above. Do not be concerned about checking if they just give values for each bracket (or indeed just an answer) – assume the have applied the correct limits unless there is contrary evidence (e.g. wrong limits stated or seen applied).

A1: Correct answer.

(c)

B1ft: Applies the surface area formula correctly with their answer to (a). The 2π and correct limits must be seen at some stage. The dt may be implied.

M1: Expands and integrates from a correct attempt at the area formula. Must be using $\int y\sqrt{\left(\frac{\mathrm{d}x}{\mathrm{d}t}\right)^2+\left(\frac{\mathrm{d}y}{\mathrm{d}t}\right)^2}\ (\mathrm{d}t)$ but again allow here if the correct formula is quoted but they subsequently forget to take the square root of (a). May be missing limits and 2π for this mark.

dM1: Applies the correct limits and simplifies to a single term. Do not be concerned about checking if they just give values for each bracket (or indeed just an answer) – assume the have applied the correct limits unless there is contrary evidence (e.g. wrong limits stated or seen applied).

A1: Correct answer, but do not isw if they try and add "ends" to the surface and award A0 in such cases.

Note: If they neglect to square root the answer in both parts the second M in (b) and both M's in (c) may be gained. This will require a cubic integral in (b) and integrating a quartic to quintic in (c).