Question Number	Scheme	Marks
9 (a)	Attempts $12 = 3x^2 \times L \Rightarrow L = \dfrac{4}{x^2}$ or $Lx = \dfrac{4}{x}$	M1, A1
	$S = 6x^2 + 5xL = 6x^2 + \dfrac{20}{x}$	dM1, A1
		(4)
(b)	$\dfrac{\mathrm{d}S}{\mathrm{d}x} = 12x - \dfrac{20}{x^2}$	M1, A1ft
	$\dfrac{\mathrm{d}S}{\mathrm{d}x} = 0 \Rightarrow x^3 = \dfrac{5}{3} \Rightarrow x = 1.18563...$	dM1
	$S\big\vert_{x=1.18563} = 6 \times "1.18563"^2 + \dfrac{20}{"1.18563"} = 25.3\,(\mathrm{m}^2)$	ddM1, A1
		(5)
(c)	$\left(\dfrac{\mathrm{d}^2S}{\mathrm{d}x^2} =\right) 12 + \dfrac{40}{x^3}$	M1
	Justifies $\dfrac{\mathrm{d}^2S}{\mathrm{d}x^2} > 0$ (at $x = 1.18563...$), hence minimum *	A1*
		(2)
		(11 marks)

(a)

M1: Attempts to use a volume formula to make L or Lx the subject. May be seen substituted into a surface area expression which is not in the required form of the final answer.

Allow $12 = \alpha x^2 L \Rightarrow L = \dfrac{\beta}{x^2}$ or $Lx = \dfrac{\beta}{x}$

A1: $L = \dfrac{4}{x^2}$ OR $Lx = \dfrac{4}{x}$ o.e. Maybe seen substituted into the equation for the surface area.

dM1: Substitutes $L = \dfrac{"4"}{x^2}$ OR $Lx = \dfrac{"4"}{x}$ into $S = Rx^2 + TxL$ which may be unsimplified to produce a formula of the correct form. It is dependent on the previous method mark.

A1: $S = 6x^2 + \dfrac{20}{x}$

Must see "$S =$" or e.g. "(surface) area = " connected at some point with $6x^2 + \dfrac{20}{x}$

They may work algebraically using *P* and *Q*. They can still score M1A1ft in (b) but they would have to substitute in their values to score any further marks in (b) or any marks in (c)

(b) **Condone other letters used instead of *S* and *x* for $\frac{\mathrm{d}S}{\mathrm{d}x}$ including *y* for *S*.**

Accept use of e.g. S'

M1: Correct form for the derivative $\left(\frac{\mathrm{d}S}{\mathrm{d}x} =\right) ax+\frac{b}{x^2}$

A1ft: Follow through on the derivative of their $S = Px^2 + \frac{Q}{x} \Rightarrow 2Px - \frac{Q}{x^2}$

dM1: Solves $\frac{\mathrm{d}S}{\mathrm{d}x} = 0 \Rightarrow x = ...$ Do not be concerned by the mechanics of the rearrangement as long as a value for *x* is achieved. =0 may be implied by further work or if just a correct value for *x* then you may need to check this. It is dependent on the previous method mark.

ddM1: Substitutes their value of *x* in *S* to find *S*. Condone slips. It is dependent on the previous two method marks.
If only a value is stated you may need to check this.

A1: awrt 25.3 (m^2) following correct differentiation. Units not required.

(c) **Note the final A1* can only be scored using a correct expression for $\frac{\mathrm{d}^2S}{\mathrm{d}x^2}$ or $\frac{\mathrm{d}S}{\mathrm{d}x}$ (depending on the approach taken). Condone other letters used instead of *S* and *x* for $\frac{\mathrm{d}^2S}{\mathrm{d}x^2}$ including *y* for *S*. Accept use of e.g.** S''

If second differentiation is seen in (b) then it must be seen or used in (c) to score.

M1: Differentiates and finds $\frac{\mathrm{d}^2S}{\mathrm{d}x^2}$ of the form $M + \frac{N}{x^3}$ (do not be concerned about signs for this mark).
Alternatively, substitutes in values of *x* above and below their 1.1856.. and proceeds to find values for $\frac{\mathrm{d}S}{\mathrm{d}x}$ at these points.

A1*: **Either** justifies $\frac{\mathrm{d}^2S}{\mathrm{d}x^2} > 0$, which must be a correct expression AND gives a minimal conclusion
Requires one of:

- a correct value for $\frac{\mathrm{d}^2S}{\mathrm{d}x^2}$ (awrt 36 if using 1.18(56..) but allow awrt 35.1 if using 1.2) from a correct expression, a correct comparison with 0 and a conclusion e.g. min
- deduces that as 12 and 40 are both positive and the correct value of *x* (awrt 1.2) > 0 then $\frac{\mathrm{d}^2S}{\mathrm{d}x^2} > 0$ with a conclusion e.g. proven

Or justifies there is a change of sign for $\frac{\mathrm{d}S}{\mathrm{d}x}$ AND gives a minimal conclusion

Requires both calculations to be correct using a correct expression for $\frac{\mathrm{d}S}{\mathrm{d}x}$ (you will need to check this)

Question Number	Scheme	Marks
10	Sets $m=3p+1$ or $m=3p+2$ ($p>0$) o.e. and attempts m^2+3m+2	M1
	E.g. $m^2+3m+2=(3p+1)^2+3(3p+1)+2=9p^2+15p+6=3\left(3p^2+5p+2\right)$	A1
	Sets $m=3p+1$ and $m=3p+2$ ($p>0$) and attempts m^2+3m+2	dM1
	E.g. $m^2+3m+2=(3p+2)^2+3(3p+2)+2=9p^2+21p+12=3\left(3p^2+7p+4\right)$	
	And gives a minimal conclusion *	A1* **(4 marks)**

Main scheme algebraic method using e.g. $m=3p+1$ and $m=3p+2$
You will need to look at both cases and mark the one which is fully correct first.
Allow a different variable to *p* and may be different letters for the two cases.
Condone use of *m* as a variable for the first three marks.
There should be no errors in the algebra for the A marks including invisible brackets.

Note that there are other allowable pairs of combinations covering the two distinct cases
e.g. $m=3p-1$ **and** $m=3p+1$ **or e.g.** $m=3p-2$ **and** $m=3p+2$
but not e.g. $m=3p-1$ **and** $m=3p+2$

Note: An attempt substituting in values rather than using algebra will score 0 marks.

M1: Sets $m=3p+1$ o.e **or** $m=3p+2$ o.e., expands m^2+3m+2 and achieves a quadratic expression which may be unsimplified

A1: Correct quadratic expression with constant terms collected for m^2+3m+2 for either of the two cases and shows or gives a reason why the expression is a multiple of 3. They must have fully multiplied out or the quadratic expression must have a factor of 3 taken out.
Do not isw if they simplify their quadratic incorrectly.

e.g. $9p^2+15p+6$ and states each term is a multiple of 3 or alternatively, correctly divides by 3 and concludes that it is divisible by 3

e.g. $3\left(3p^2+5p+2\right)$ or e.g. $3(3p^2+2p)+3(3p+1)+3$

e.g. $9p^2+21p+12$ and states each term is a multiple of 3 or alternatively correctly divides by 3 and concludes that it is divisible by 3

e.g. $3\left(3p^2+7p+4\right)$

dM1: Sets $m=3p+1$ o.e **and** $m=3p+2$ o.e. and expands m^2+3m+2 and achieves two quadratic expressions which may be unsimplified. See first M1 for guidance. It is dependent on the previous method mark.