Question Number	Scheme	Marks
10(a)	$(V=)50=\pi r^2 h$	B1
	$A=2\pi r^2+2\pi rh=2\pi r^2+2\pi r\times\dfrac{50}{\pi r^2}$	M1
	$A=2\pi r^2+\dfrac{100}{r}$ *	A1 (3)
(b)	$\dfrac{\mathrm{d}A}{\mathrm{d}r}=4\pi r-\dfrac{100}{r^2}$	M1
	$\dfrac{\mathrm{d}A}{\mathrm{d}r}=0\ \Rightarrow 4\pi r=\dfrac{100}{r^2}$	M1
	$r=\sqrt[3]{\dfrac{100}{4\pi}}=\sqrt[3]{7.9577...}=1.996$	A1 (3)
(c)	$\dfrac{\mathrm{d}^2A}{\mathrm{d}r^2}=4\pi+\dfrac{200}{r^3}$	M1
	$r=1.996\Rightarrow\dfrac{\mathrm{d}^2A}{\mathrm{d}r^2}>0\ \ \therefore\min$	M1A1 cso (3)
(d)	$A_{\min}=2\pi\times1.996^2+\dfrac{100}{1.996}$	M1
	$A_{\min}=75$	A1cso (2) **[11]**

Notes

(a)

B1 for equating the formula for the volume of a cylinder to the given volume of 50

M1 for substituting their $50 = \pi r^2 h$ into the formula for the surface area of a cylinder

$S = 2\pi r^2 + 2\pi rh$

A1 for the answer as shown (this is a show question; beware of 'fudging' answers)

(b)

M1 for an attempt to differentiate the **GIVEN** expression only for S

M1 for setting their $\frac{\mathrm{d}A}{\mathrm{d}r} = 0$

Accept $4\pi r = \frac{100}{r} \Rightarrow r = ...$

A1 for the answer as shown $r = 1.996$

(c)

M1 for attempting to find the second derivative of their $\frac{\mathrm{d}A}{\mathrm{d}r}$ (see General Guidance)

M1 for substituting their value of r into their $\frac{\mathrm{d}^2\mathrm{A}}{\mathrm{dr}^2}$, but r must be positive.

A1 for $\frac{\mathrm{d}^2 A}{\mathrm{d}r^2} > 0$ hence minimum cso Their value for $\frac{\mathrm{d}^2 A}{\mathrm{d}r^2}$ must be correct (37.716.. when $r = 1.9966$.)

Also accept a conclusion by inspection. ie., 4π and $\frac{100}{r^3}$ are both positive hence $\frac{\mathrm{d}^2 A}{\mathrm{d}r^2} > 0$

ALT

M1 for substituting a value for r < '1.996' **or** r > '1.996' to test gradient $\frac{\mathrm{d}A}{\mathrm{d}r}$ around r = '1.996'.

When $r < 1.996$ $\frac{\mathrm{d}A}{\mathrm{d}r} < 0$, when $r > 1.996$, $\frac{\mathrm{d}A}{\mathrm{d}r} > 0$.

M1 for substituting a value for r < '1.996' **and** r > '1.996' to test $\frac{\mathrm{d}A}{\mathrm{d}r}$.

A1 for conclusion; that as r increases the gradient goes from negative to positive hence, minimum.

(d)

M1 for substituting their r into the **GIVEN** expression for A and evaluating, but their r must be a positive value.

A1 for $A_{\min} = 75$ cso