Question	Scheme	Marks
8 (a)	$90\pi = \pi r^2 h \Rightarrow h = \dfrac{90}{r^2}$ $S = 2\pi r^2 + 2\pi rh \Rightarrow S = 2\pi r^2 + 2\pi r \times \dfrac{90}{r^2}$ $S = 2\pi r^2 + \dfrac{2\times 90\pi}{r} = 2\pi r^2 + \dfrac{180\pi}{r}$ *	B1 M1 A1cso [3]
(b)	$\dfrac{\mathrm{d}S}{\mathrm{d}r} = 4\pi r - \dfrac{180\pi}{r^2}$ $\dfrac{\mathrm{d}S}{\mathrm{d}r} = 0 \Rightarrow 4\pi r - \dfrac{180\pi}{r^2} = 0 \Rightarrow 4\pi r = \dfrac{180\pi}{r^2} \Rightarrow r^3 = 45 \Rightarrow r = ...$ $r = 3.55689... \Rightarrow r \approx 3.56$ $\dfrac{\mathrm{d}^2 S}{\mathrm{d}r^2} = 4\pi + \dfrac{360\pi}{r^3}$ $\dfrac{d^2S}{dr^2} = 4\pi + \dfrac{360\pi}{r^3} \Rightarrow \left(\dfrac{d^2S}{dr^2} = 37.699\ldots\right)$ $37.699 > 0 \Rightarrow$ hence minimum	M1 M1 A1 M1 A1ft [5]
(c)	$S = 2\pi \times 3.556...^2 + \dfrac{2\times 90\pi}{3.556..} = ...$ $S = 238.4769... \Rightarrow S = 238\ \left(\mathrm{cm}^2\right)$	M1 A1 [2]
		Total 10 marks

Part	Marks	Scheme
(a)	**B1**	For finding an expression for h in terms of r $90\pi = \pi r^2 h \Rightarrow h = \dfrac{90}{r^2}$ Award for finding an expression for hr in terms of r $90\pi = \pi r^2 h \Rightarrow hr = \frac{90}{r}$
	M1	For substituting their expression for h into a **correct** formula for the closed surface area of a cylinder $S = 2\pi r^2 + 2\pi rh \Rightarrow S = 2\pi r^2 + 2\pi r \times \frac{'90'}{r^2}$ Or for substitution of their expression for hr into a **correct** formula for the closed surface area of a cylinder $S = 2\pi r^2 + 2\pi rh \Rightarrow S = 2\pi r^2 + 2\pi \times \frac{'90'}{r}$
	A1 cso	For the correct expression for the area as shown

		$S = 2\pi r^2 + \frac{2\times 90\pi}{r} = 2\pi r^2 + \frac{180\pi}{r}$ Must have the $S =$ for this mark.
(b)	**M1**	For attempting to differentiate the given expression for S at least one power to decrease and neither power to increase. $\frac{\mathrm{d}S}{\mathrm{d}r} = 4\pi r - \frac{180\pi}{r^2}$
	M1	Sets their $\frac{\mathrm{d}S}{\mathrm{d}r} = 0$ and attempts to solve for r $4\pi r - \frac{180\pi}{r^2} = 0 \Rightarrow 4\pi r = \frac{180\pi}{r^2} \Rightarrow r^3 = 45 \Rightarrow r = ...$
	A1	For the correct value of $r = 3.55689... \Rightarrow r \approx 3.56$ Accept awrt 3.56
	M1	For attempting to differentiate their expression for $\frac{\mathrm{d}S}{\mathrm{d}r}$ at least one power to decrease and neither power to increase. $\frac{\mathrm{d}^2S}{\mathrm{d}r^2} = 4\pi + \frac{360\pi}{r^3}$
	A1ft	For correct work throughout $\frac{\mathrm{d}^2S}{\mathrm{d}r^2} = 4\pi + \frac{180\pi}{r^3} \Rightarrow \left(\frac{\mathrm{d}^2S}{\mathrm{d}r^2} = 37.699...\right)$ $37.699 > 0 \Rightarrow$ hence minimum Evaluation not required as both terms positive so $\frac{\mathrm{d}^2S}{\mathrm{d}r^2} > 0$ hence minimum Indication of positive or >0 required. If $\frac{\mathrm{d}^2S}{\mathrm{d}r^2}$ evaluated incorrectly then do not award. If evaluated then accept awrt 38
(c)	**M1**	For substituting their value of r into the **given** expression for S $S = 2\pi \times '3.556'...^2 + \frac{2\times 90\pi}{'3.556'..} = ...$ Their value of r >0
	A1	$S = 238.4769... \Rightarrow S = 238\ (\mathrm{cm}^2)$ Accept awrt 238