Question			Answer	Marks	AO	Guidance	
3	(a)		$\pi r^2 h = 16000\pi$	**B1**	**3.1b**	Correct equation for volume seen or used	h likely to be used, but could be other variable
			$A = 2\pi r^2 + 2\pi r h$	**B1**	**3.1b**	Correct expression for surface area seen	Two terms may be seen at separate stages of the proof If alternative formula used eg $2\pi r^2 + 2Vr^{-1}$ then this must be clearly derived Allow BOD for $2\pi r^2 + 2\pi r \times 16000 r^{-2}$ as long as h seen explicitly in terms of r first
			$= 2\pi r^2 + 2\pi r \times 16000 r^{-2}$	**M1**	**1.1a**	Eliminate h from expression for surface area	Allow if just attempt at curved surface area
			$= 2\pi r^2 + 32000\pi r^{-1}$ **A.G.**	**A1**	**1.1**	Obtain given answer	If $2\pi r^2$ is first seen in the final answer then it must be justified eg 'plus two ends', otherwise max B1B0M1A0
				[4]			

Question			Answer	Marks	AO	Guidance	
	(b)		$\frac{dA}{dr} = 4\pi r - 32000\pi r^{-2}$	M1	1.1a	Attempt differentiation	Both powers decrease by 1
			$4\pi r - 32000\pi r^{-2} = 0$ $r^3 = 8000$	M1	3.1b	Equate derivative to 0 and attempt to solve for *r* (or *h*)	$-32000\pi h^{-2} + \pi\sqrt{16000}h^{-\frac{1}{2}}$
			$r = 20$	A1	1.1	Obtain correct *r*, units not needed	$h^{\frac{3}{2}} = \sqrt{64000}$
			Surface area $= 2400\pi$ cm^2 / 7540 cm^2	A1	1.1	Obtain correct *A*, units not needed	Allow exact or decimal (3sf or better)
			$\frac{d^2A}{dr^2} = 4\pi + 64000\pi r^{-3}$ when $r = 20$, $\frac{d^2A}{dr^2} = 12\pi$ (or 37.7)	M1	2.1	Attempt method to justify minimum, including substitution or consideration of sign	Could also test first derivative, or *A*, on both sides of $r = 20$
			$\frac{d^2A}{dr^2} > 0$, hence minimum	A1	2.2a	Correct conclusion, with justification, from correct working	If second derivative is evaluated, it must be correct (condone truncated decimal of 37.6)
				[6]			