Q	Marking Instructions (I)	AO	Marks	Typical Solution (using r)
11	Obtains correct weld length in terms of h and r	AO1.1b	B1	Length of weld $= w = h + 2\pi r$ Volume $= 8000 = \pi r^2 h$
	Obtains formula for h in terms of r or vice versa using volume = 8000	AO3.1b	M1	So $h = \frac{8000}{\pi r^2}$
	Substitutes to get weld length in terms of one variable, obtaining correct formula for w	AO1.1b	A1	$w = \frac{8000}{\pi r^2} + 2\pi r$
	States that for a stationary point the first derivative is zero. (OE)	AO2.4	E1	For minimum length of weld $\frac{dw}{dr} = 0$
	Differentiates correctly (FT provided formula includes negative powers) (accept numerical value of $-\frac{16000}{\pi}$ used)	AO1.1b	B1F	$\frac{-16000}{\pi r^3} + 2\pi = 0$ leading to $\pi^2 r^3 = 8000$
	Solves to find a value of r and a value of h (do not award if the final value of r or h is negative)	AO1.1a	M1	$r = 9.32$ cm $h = 29.3$ cm
	Obtains r = 9 or 9.3 (AWRT) and h = 29, 29.3 (AWRT) or 30	AO1.1b	A1	
	Differentiates 'their' first differential and substitutes in 'their' value of r or h	AO1.1a	M1	$\frac{d^2w}{dr^2} = \frac{48000}{\pi r^4}$
	Sets out a well-constructed mathematical argument, using precise statements throughout to find the values of r (9 or 9.3) and h (29, 29.3 or 30) and justifies the minimum value. Can be awarded if E1 not obtained.	AO2.1	R1	which is positive, so this is a minimum for w
	Total		**9**	

Q	Marking Instructions (II)	AO	Marks	Typical Solution (using h)
11				Length of weld = $w = h + 2\pi r$ Volume = $8000 = \pi r^2 h$ $r = \sqrt{\frac{8000}{\pi h}}$ $w = h + 2\pi\sqrt{\frac{8000}{\pi h}}$ $= h + \sqrt{32000\pi}h^{-\frac{1}{2}}$ For minimum length of weld $\frac{dw}{dh} = 0$ $1 - \frac{1}{2}\sqrt{32000\pi}h^{-\frac{3}{2}} = 0$ leading to $h^3 = 8000\pi$ $h = 29.3$ cm $r = 9.32$ cm $\frac{d^2w}{dh^2} = \frac{3}{4}\sqrt{32000\pi}h^{-\frac{5}{2}}$ which is positive, so this is a minimum for w
	Total		**9**	