Question number	Scheme	Marks
9 (a)	$540 = 3x^2h \Rightarrow h = \frac{180}{x^2}$ $S = 2\left(3x^2 + 3xh + xh\right) = 6x^2 + 8xh$ $\Rightarrow S = 6x^2 + 8x \times \frac{180}{x^2} = 6x^2 + \frac{1440}{x}$ *	M1 M1 depM1A1 [4]
(b)	$S = 6x^2 + 1440x^{-1}$ $\frac{dS}{dx} = 12x - 1440x^{-2}$ At min/max $\frac{dS}{dx} = 0$ $12x - 1440x^{-2} = 0 \Rightarrow x^3 = 120 \Rightarrow x = 4.93242....$ $x \approx 4.93$ (3sf) $\frac{d^2S}{dx^2} = 12 + \frac{2880}{x^3} \Rightarrow$ Always positive for positive values of x, hence minimum	 M1 M1A1 M1A1ft [5]
(c)	$S = 6 \times 4.93242^2 + \frac{1440}{4.93242} = 437.9185 \approx 438$	B1 [1]
		Total 10 marks
(a) M1 M1 depM1 A1 (b) M1 M1 A1 M1 A1 ft (c) B1	 Rearrange the equation for volume to make h the subject Obtains an expression for S in terms of x and h. Dependent on previous M1. Use the equation to eliminate h to give an expression for S in terms of x only. Obtains the **given** expression for S. Attempts to differentiates S wrt x with $x^n \to x^{n-1}$ Equate their derivative to zero and solve for x Correct value of x, min 3 sf (Do not accept $\sqrt[3]{120}$) Obtains a correct second derivative from their first derivative. (If signs of $\frac{dS}{dx}$ on either side of their x are considered, numerical calculations must be shown.) Establish that the minimum has been obtained and give a conclusion. No need to calculate the value of the second derivative. Follow through their x provided $x > 0$ and the second derivative is algebraically correct or if signs of $\frac{dS}{dx}$ on either side of their x were considered these need to be calculated and correct Correct value of S. Must be 3 sf	