Q	Marking instructions	AO	Marks	Typical solution
9(a)	Identifies and clearly defines variable for radius of cylinder. Can be shown on diagram or can be implied by use in $V = \pi r^2 h$	2.5	B1	Radius of cylinder = r $h^2 + r^2 = R^2$ $V = \pi r^2 h$
	Uses Pythagoras to connect h, r and R	3.1a	M1	
	Eliminates the radius variable to form an expression for the volume of the cylinder in terms of h, completing argument to show given result. Condone undefined r	2.1	R1	$V = \pi\left(R^2 - h^2\right)h$ $= \pi R^2 h - \pi h^3$
	Subtotal		**3**	
9(b)	Differentiates the expression for volume w.r.t. h with at least one term correct.	3.1a	M1	$\frac{\mathrm{d}V}{\mathrm{d}h} = \pi R^2 - 3\pi h^2$
	Obtains correct $\frac{\mathrm{d}V}{\mathrm{d}h}$	1.1b	A1	For maximum volume $\frac{\mathrm{d}V}{\mathrm{d}h} = 0$
	Explains that their derivative w.r.t h equals zero for a maximum or stationary point	2.4	E1	$\Rightarrow R^2 - 3h^2 = 0$ $h^2 = \frac{R^2}{3} \Rightarrow h = \frac{R}{\sqrt{3}}$
	Equates volume derivative w.r.t. h to zero and correctly obtains a value for h in terms of R	1.1a	M1	
	Substitutes their h, in terms of R, from derivative w.r.t. h into volume formula.	1.1a	M1	Hence volume $V = \pi R^2 \frac{R}{\sqrt{3}} - \pi\left(\frac{R}{\sqrt{3}}\right)$
	Obtains the correct max volume in the form $kR^3 - pR^3$ or better	3.2a	A1	$= \frac{2\sqrt{3}\pi R^3}{9}$
	Justifies correct volume in the form $kR^3 - pR^3$ or better form is the maximum eg: • V = 0 when h=0 or R and V>0 in between. • Sketches shape of graph passing through the origin with (min on negative side) and max on positive side • Obtains $\frac{\mathrm{d}^2V}{\mathrm{d}h^2} = -6\pi h < 0$ NB R1 can be awarded even if E1 is not awarded.	2.1	R1	$\frac{\mathrm{d}^2V}{\mathrm{d}h^2} = -6\pi h$ When $h = \frac{R}{\sqrt{3}}$ $\frac{\mathrm{d}^2V}{\mathrm{d}h^2} < 0$ Therefore maximum

	Subtotal		7	
	Question Total		10	