Question number	Scheme	Marks
7(a)	Dimensions of box are $(16-2x)$ cm $(10-2x)$ cm and x cm	B1
	$V = x(16-2x)(10-2x) = 4x^3 - 52x^2 + 160x$ *	M1A1cso (3)
(b)	$\frac{dV}{dx} = 12x^2 - 104x + 160 = 0$	M1
	$12x^2 - 104x + 160 = (3x-20)(x-2) = 0$	
	$x = 2$ or $\frac{20}{3}$ (x cannot be $\frac{20}{3}$ as $10 - 2\times\frac{20}{3} = -\frac{10}{3}$ so $x = 2$)	dM1A1
	$\frac{d^2V}{dx^2} = 24x - 104 \Rightarrow \frac{d^2V}{dx^2} = 24\times 2 - 104 = -56$ $\{ -56 < 0$ hence max$\}$	M1A1 (5)
(c)	$V = 4\times 2^3 - 52\times 2^2 + 160\times 2 = 144$	M1A1 (2) [10]

Additional Notes		
Part	**Mark**	**Guidance**
(a)	B1	Use the dimensions of the box as $(16-2x)$ cm, $(10-2x)$ cm and x cm
	M1	Finds an expression for the volume of the box using their dimensions. $V = x(16-2x)(10-2x)$ and attempts to multiply their expression out. [Accept $V = 4x^3 - 52x^2 + 160x$ without intermediate working]
	A1	For $(V =)4x^3 - 52x^2 + 160x$ only. **Note: This is a show question -** there can be no errors for the award of this mark.
(b)	M1	Differentiates the **given** expression for V **and** sets = 0. Their differentiated expression must be a 3TQ. See general guidance for the definition of an attempt.
	dM1	Solves their differentiated equation by any acceptable method and achieves two values for x. [If they only give $x = 2$ because they discard the other value then that is fine.]
	A1	$x = 2$ $x = \frac{20}{3}$ needs to be discarded at some stage in their working for the award of this mark.
	M1	Finds the second derivative (again see General Guidance for the definition of an attempt) and substitutes either of their values of x to find a value for $\frac{d^2V}{dx^2}$
	A1	$\frac{d^2V}{dx^2} = -56$ negative hence maximum. Cao.
	ALT for 2nd Derivative Some students may test the gradient either side of their $x = 2$ and come to a conclusion based on this.	
	M1	Tests **both sides** of their x For example $x = 1.5$ and $x = 2.5$ and find the gradient using their $\frac{dy}{dx}$
	A1	Draws a correct conclusion. Eg., Gradient at $x = 1.5$ is positive, at $x = 2.5$ is negative hence going from positive to negative so maximum.
(c)	M1	Substitutes in their value of x (**which must be positive**) into the **given** expression for V and finds a volume.
	A1	$V = 144$ (coming from a correct value of x) If they also give an answer of −59.25 coming from substituting $\frac{20}{3}$ then award A0 **unless** they make it clear that the volume is 144.