

Q	Marking instructions	AO	Marks	Typical solution
11(a)	Forms a correct expression for the surface area of the block of ice Can be unsimplified terms or states that the surface area is proportional to x^2	3.1b	B1	$S.A. = 2(8x^2 + 2x^2 + 4x^2) = 28x^2$ $\frac{dV}{dt} = -28kx^2$ $x = 4, \frac{dV}{dt} = -7$
	States $\frac{dV}{dt} = m(SA) \text{ or } \frac{dV}{dt} = -m(SA)$ or $\frac{dV}{dt} = m(\text{their } 28x^2) \text{ or } \frac{dV}{dt} = -m(\text{their } 28x^2)$ or $\frac{dV}{dt} = mx^2 \text{ or } \frac{dV}{dt} = -mx^2$ Accept any letter for m	3.3	M1	$\Rightarrow -7 = -28k \times 16$ $\Rightarrow k = \frac{7}{28 \times 16} = \frac{1}{64}$ $\Rightarrow \frac{dV}{dt} = -\frac{28}{64}x^2 = -0.4375x^2$
	Substitutes $\frac{dV}{dt} = -7$ and SA = their '28×4^2' into their differential equation $\frac{dV}{dt} = m(SA) \text{ or } \frac{dV}{dt} = -m(SA)$ or substitutes $\frac{dV}{dt} = -7$ and $x = 4$ into their differential equation of the form $\frac{dV}{dt} = m(28x^2) \text{ or } \frac{dV}{dt} = -m(28x^2)$ or $\frac{dV}{dt} = mx^2 \text{ or } \frac{dV}{dt} = -mx^2$ Accept any letter for m	3.3	M1	
	Completes reasoned argument to show the given result with no incorrect expression for surface area and no incorrect substitution seen. AG To be awarded R1, marks M1M1 must be scored as the minimum Ignore units	2.1	R1	
Subtotal			4	

Q	Marking instructions	AO	Marks	Typical solution
11(b)	Forms a correct expression for the volume of the block of ice or states $8x^3$	3.1b	M1	$V = 4x \times 2x \times x$ $= 8x^3$ $\frac{dV}{dx} = 24x^2$
	Obtains $24x^2$	1.1b	A1	
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
11(c)(i)	Uses the chain rule to connect $\frac{dV}{dt} = -0.4375x^2$, their $\frac{dV}{dx} = 24x^2$ from part (b) and $\frac{dx}{dt}$	3.1a	M1	$\frac{dx}{dt} = \frac{dx}{dV} \times \frac{dV}{dt}$ $= \frac{1}{24x^2} \times -0.4375x^2$ $= -\frac{7}{384}$
	Obtains $-\frac{7}{384}$ AWFW $-[0.018, 0.0183]$	1.1b	A1	
	Subtotal		2	

Q	Marking instructions	AO	Marks	Typical solution
11(c)(ii)	Identifies the height/width/length/edge/side/dimension/measurement is decreasing at a constant rate	3.5a	E1	The height is decreasing at a constant rate of 0.018 cm per minute.
	States it occurs at the rate of $\frac{7}{384}$ or $[0.018, 0.0183]$ or $[0.036, 0.0366]$ or $[0.072, 0.0732]$ cm per minute FT their constant $\frac{dx}{dt}$ from part c(i)	3.5a	E1F	
	Subtotal		2	

	Question 11 Total		10	
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