Question	Scheme	Marks	AOs
13 (a)	Uses $V=\frac{1}{3}\pi r^2 h$ with $\frac{r}{h}=\frac{2.5}{4}$ to establish $V=\mathrm{f}(h^3)$ and differentiates	M1	2.1
	$\frac{\mathrm{d}V}{\mathrm{d}h}=\frac{75}{192}\pi h^2$	A1	1.1b
	States or uses $\frac{\mathrm{d}V}{\mathrm{d}t}=-\frac{\pi}{512}\sqrt{h}$	B1	1.1b
	Uses $\frac{\mathrm{d}V}{\mathrm{d}t}=\frac{\mathrm{d}V}{\mathrm{d}h}\times\frac{\mathrm{d}h}{\mathrm{d}t}$ with their $\frac{\mathrm{d}V}{\mathrm{d}t}$ and their $\frac{\mathrm{d}V}{\mathrm{d}h}$	M1	3.1b
	$--\frac{\pi}{512}\sqrt{h}=\frac{75}{192}\pi h^2\times\frac{\mathrm{d}h}{\mathrm{d}t}\Rightarrow h^{\frac{3}{2}}\frac{\mathrm{d}h}{\mathrm{d}t}=-\frac{1}{200}$ *	A1*	2.1
		(5)	
(b)	$\int h^{\frac{3}{2}}\mathrm{d}h=-\int\frac{1}{200}\mathrm{d}t\Rightarrow\frac{2}{5}h^{\frac{5}{2}}=-\frac{1}{200}t+c$	M1	1.1b
	Substitutes $t=0, h=4\Rightarrow c=\left(\frac{64}{5}\right)$	dM1	3.4
	$\frac{2}{5}h^{\frac{5}{2}}=-\frac{1}{200}t+\frac{64}{5}$ oe	A1	3.3
		(3)	
(c)	Substitutes $h=0\Rightarrow 0=-\frac{1}{200}t+\frac{64}{5}\Rightarrow t=...$	M1	3.4
	$t=2560$ seconds = 42 minutes 40 seconds	A1	3.2a
	States that the "real" time and the "predicted" times are very close so model seems suitable	A1	3.5a
		(3)	
			(11 marks)

Notes:

(a)

M1: Uses $V=\frac{1}{3}\pi r^2 h$ with $\frac{r}{h}=\frac{2.5}{4}$ or equivalent to establish V as a function of h^3 which is then differentiated to an expression in h^2

A1: $\frac{\mathrm{d}V}{\mathrm{d}h}=\frac{75}{192}\pi h^2$

B1: Uses the information given in the question to states or uses $\frac{\mathrm{d}V}{\mathrm{d}t}=-\frac{\pi}{512}\sqrt{h}$

M1: Uses $\frac{\mathrm{d}V}{\mathrm{d}t}=\frac{\mathrm{d}V}{\mathrm{d}h}\times\frac{\mathrm{d}h}{\mathrm{d}t}$ with their $\frac{\mathrm{d}V}{\mathrm{d}t}$ and their $\frac{\mathrm{d}V}{\mathrm{d}h}$ to form an equation linking $\frac{\mathrm{d}h}{\mathrm{d}t}$ and h

A1*: Proceeds correctly to the given equation $h^{\frac{3}{2}}\frac{\mathrm{d}h}{\mathrm{d}t}=-\frac{1}{200}$

(b)

M1: Integrates both sides to $ah^{\frac{5}{2}} = bt + c$. Condone the omission of + c for this mark

dM1: Uses the model to find c

A1: Finds the equation of the model Eg. $\frac{2}{5}h^{\frac{5}{2}} = -\frac{1}{200}t + \frac{64}{5}$ or equivalent such as $h^{\frac{5}{2}} = -\frac{1}{80}t + 32$

(c)

M1: Uses the model with $h = 0$ and proceeds to find t

A1: Achieves $t = 2560$ seconds and converts this or the 43 minutes as required in order to test the model

A1: States that the "real" time and the "predicted" times are very close so the model seems suitable