Question Number	Scheme	Marks
3	$V = \frac{4}{3}\pi r^3 \rightarrow \frac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$	M1A1
	$36000\pi = \frac{4}{3}\pi r^3 \quad \Rightarrow r = 30$	M1A1
	$\frac{\mathrm{d}r}{\mathrm{d}t} = \frac{\mathrm{d}V}{\mathrm{d}t} \times \frac{\mathrm{d}r}{\mathrm{d}V}$ oe	M1
	$\frac{\mathrm{d}r}{\mathrm{d}t} = 60 \times \frac{1}{4\pi \times 30^2} \quad \Rightarrow \frac{\mathrm{d}r}{\mathrm{d}t} = \frac{1}{60\pi} = 0.0053\,\mathrm{cm/s}$	M1A1
		(7)

Notes

M1 for attempting to differentiate the expression for the volume of a sphere. If their formula is incorrect allow $V = a\pi r^3$ where a is a constant as a minimum.
(see General Guidance for an attempt)

A1 for a fully correct $\frac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$

M1 for equating the given volume to the correct formula for the volume of a sphere **AND** attempting to find the value for r. **Just equating the given volume to the formula is not enough for the award of this mark. They must reach r =……**

A1 $r = 30$

M1 for a correct expression of chain rule (any way around) there will be some variations so please check anything unusual.

M1 for substituting their $\frac{\mathrm{d}V}{\mathrm{d}r}$, and using the given value of $\frac{\mathrm{d}V}{\mathrm{d}t}$ to find $\frac{\mathrm{d}r}{\mathrm{d}t}$.

A1 for a correct value of 0.0053 (cm/s)
(Units not required)

ALT

M1 for re-arranging the formula for the volume of a sphere to make r the subject

An acceptable attempt is $r = \left(\frac{aV}{b}\right)^{\frac{1}{3}}$ where a and b are constants

A1 for $r = \left(\frac{3V}{4\pi}\right)^{\frac{1}{3}}$

M1 for attempting to differentiate a rearranged formula for the volume of a sphere

$$r = \left(\frac{3V}{4\pi}\right)^{\frac{1}{3}} \Rightarrow \frac{\mathrm{d}r}{\mathrm{d}V} = \frac{V^{-\frac{2}{3}}}{3}\left(\frac{3}{4\pi}\right)^{\frac{1}{3}}$$

A1 for a fully correct $\frac{\mathrm{d}r}{\mathrm{d}V}$

M1 for a correct expression of chain rule

M1 for substituting the given V into their differentiated $\frac{\mathrm{d}r}{\mathrm{d}V}$, using the given $\frac{\mathrm{d}V}{\mathrm{d}t}$ and using a correct chain rule.

A1 for a correct value of 0.0053 (cm/s)