Question	Answer	Marks	Partial marks
6	$r = 3$ nfww	**B1**	stated or very clearly implied
	$2\pi = 4\pi r^2 \times \frac{dr}{dt}$ soi or $\frac{dr}{dt} = \frac{1}{2r^2}$ oe and $\frac{dS}{dr} = 8\pi r$	**M1**	Uses relevant chain rule e.g. $\frac{dV}{dt} = \frac{dV}{dr} \times \frac{dr}{dt}$ to find the derivatives and values of $\frac{dr}{dt}$ and $\frac{dS}{dr}$
	$\frac{dr}{dt} = \frac{1}{18}$ and $\frac{dS}{dr} = 24\pi$ soi	**A1**	
	Correct chain rule including $\frac{dS}{dt}$	**B1**	e.g. $\frac{dS}{dt} = \frac{dS}{dr} \times \frac{dr}{dt}$ or $\frac{dr}{dt} = \frac{dS}{dt} \times \frac{dr}{dS}$ oe
	$\frac{dS}{dt} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**2**	**M1** for $\frac{dS}{dt} = 24\pi \times \frac{1}{18}$
	Alternative method 1		
	$r = 3$ nfww	**(B1)**	stated or very clearly implied
	$\frac{dV}{dr} = 4\pi r^2$ and $\frac{dS}{dr} = 8\pi r$	**(M1)**	Finds correct expressions for and values of $\frac{dV}{dr}$ and $\frac{dS}{dr}$
	$\frac{dV}{dr} = 36\pi$ and $\frac{dS}{dr} = 24\pi$ soi	**(A1)**	
	Correct chain rule including $\frac{dS}{dt}$	**(B1)**	e.g. $\frac{dS}{dt} = \frac{dS}{dr} \times \frac{dr}{dV} \times \frac{dV}{dt}$ or $\frac{dS}{dt} = \frac{dS}{dV} \times \frac{dV}{dt}$
	$\frac{dS}{dt} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**(2)**	**M1** for $\frac{dS}{dt} = 24\pi \times \frac{1}{36\pi} \times 2\pi$ or $\frac{2}{3} \times 2\pi$

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Question	Answer	Marks	Partial marks
6	**Alternative method 2**		
	$r = \sqrt[3]{\frac{3V}{4\pi}}$ nfww	**(B1)**	stated or very clearly implied
	$S = 4\pi\left(\sqrt[3]{\frac{3V}{4\pi}}\right)^2 \rightarrow \frac{\mathrm{d}S}{\mathrm{d}V} = 4\pi \times \left(\frac{3}{4\pi}\right)^{\frac{2}{3}} \times \frac{2}{3}V^{-\frac{1}{3}}$	**(M1)**	
	$\frac{\mathrm{d}S}{\mathrm{d}V} = \frac{2}{3}$ oe soi	**(A1)**	
	Correct chain rule including $\frac{\mathrm{d}S}{\mathrm{d}t}$	**(B1)**	e.g. $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{\mathrm{d}S}{\mathrm{d}V} \times \frac{\mathrm{d}V}{\mathrm{d}t}$
	$\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**(2)**	**M1**for $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{2}{3} \times 2\pi$
	Alternative method 3		
	$r = 3$ nfww	**(B1)**	stated or very clearly implied
	$r = \sqrt{\frac{S}{4\pi}}, V = \frac{4}{3}\pi\left(\sqrt{\frac{S}{4\pi}}\right)^3$, $\frac{\mathrm{d}V}{\mathrm{d}S} = \frac{4}{3}\pi \times \frac{1}{(4\pi)^{\frac{3}{2}}} \times \frac{3}{2}S^{\frac{1}{2}}$	**(M1)**	
	$S = 36\pi$ **and** $\frac{\mathrm{d}V}{\mathrm{d}S} = \frac{3}{2}$ oe soi	**(A1)**	
	Correct chain rule including $\frac{\mathrm{d}S}{\mathrm{d}t}$	**(B1)**	e.g. $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{\mathrm{d}S}{\mathrm{d}V} \times \frac{\mathrm{d}V}{\mathrm{d}t}$
	$\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{4\pi}{3}$ isw or 4.19 or 4.188 to 4.1888	**(2)**	**M1** for $\frac{\mathrm{d}S}{\mathrm{d}t} = \frac{1}{1.5} \times 2\pi$

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Question	Answer	Marks	Partial marks
7(a)	Forms a correct equation from which the logarithms can be eliminated : has consistent powers of ln$x$ in all terms $\frac{n}{2}\left(12\ln x+\left(n-1\right)\times 4\ln x\right)*43\times 24\ln x$ oe, soi OR uses log laws to combine terms $\ln\left(x^{6n}\times x^{2n(n-1)}\right)*\ln x^{24\times 43}$ or better	**3**	where * is = or any inequality sign **M2** for $a = 6$ **and** $d = 4$ or $a = 6\ln x$ soi **and** $d = 4\ln x$ soi or $a = \ln x^6$ soi **and** $d = \frac{2}{3}\ln x^6$ soi or $a = \frac{3}{2}\ln x^4$ soi **and** $d = \ln x^4$ soi or for $\ln x^{12\times\frac{n}{2}}+\ln x^{4(n-1)\times\frac{n}{2}}*\ln x^{24\times 43}$ oe or **M1** for any correct expression for d or for a correct expression for the sum to n terms using *their a* and *their d* providing *their d* is not one of the given terms
	$2n^2+4n-1032\left[*0\right]$ oe	**A1**	
	Solves *their* 3-term quadratic in n	**M1**	**dep** on attempt at the sum of an AP
	$n = 22$ cao, nfww	**A1**	**dep** on all previous marks awarded

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