Question Number	Scheme	Marks
3(a)	$B = 6\times 4^{-\frac{1}{2}} = 3$	B1
	$3\times\left(-\frac{1}{2}\right)\left(\frac{A}{4}\right) = -\frac{1}{4} \Rightarrow A = \frac{2}{3}$	M1 A1
	$C = 3\times\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)}{2}\left(\frac{A}{4}\right)^2 \Rightarrow C = \frac{1}{32}$	M1 A1
		(5)

Notes:

(a)

B1: For $B = 3$ which may be implied by their expansion e.g. $3\pm...$

M1: Attempts to find A condoning the omission of their "3".

Look for $-\frac{1}{2}\times\left(\frac{Ax}{m}\right) = -\frac{1}{4}x$ o.e. where m could be 1 leading to a value for A.

Must be consistent with their $...\left(1+\frac{A}{m}x\right)^{-\frac{1}{2}}$ but condone the omission of the "3".

Note the omission of the "3" (if correct) leads to $A = 2$.

A1: $A = \frac{2}{3}$ or an exact equivalent or e.g. $0.\dot{6}$

Allow if seen embedded in $6(4+Ax)^{-\frac{1}{2}}$

M1: Attempt to find C condoning the omission of their "3".

Look for $\frac{\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)}{2}\times\left(\frac{A}{m}\right)^2 = ...$ or $\frac{\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)}{2}\times\left(\frac{Ax}{m}\right)^2 = ...$ oe with their numerical value of A leading to a value for C

Must be consistent with their $...\left(1+\frac{A}{m}x\right)^{-\frac{1}{2}}$ where m could be 1

Note the omission of the "3" (if correct) with a correct A leads to $C = \frac{1}{96}$.

A1: $C = \frac{1}{32}$ oe e.g. 0.03125

Allow if seen embedded in their expansion.

3(b)	$-6 < x \leqslant 6$	B1ft
		(1)
(c)	coefficient of x^3 is $3\times\frac{\left(-\frac{1}{2}\right)\left(-\frac{3}{2}\right)\left(-\frac{5}{2}\right)}{3!}\left(\frac{A}{4}\right)^3=\ldots$	M1
	$-\frac{5}{1152}$	A1
		(2)

Notes:

(b)

B1ft: $-6 < x \leqslant 6$ but follow through on their A so allow for $-\frac{4}{A} < x \leqslant \frac{4}{A}$

Condone strict or non-strict inequalities for either end e.g. condone $|x| < 6$

or e.g. $-6 < x < 6$ but follow through on their A e.g. condone $|x| \leqslant \left|\frac{4}{"A"}\right|$

Accept alternative notation e.g. $x > -6$ and $x \leqslant 6$, $(-6, 6)$, $(-6, 6]$ etc.

(c)

M1: Attempt to find the coefficient of x^3 or the term in x^3 to obtain a value condoning the omission of their "3".

Look for an attempt at $\frac{\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)\times\left(-\frac{5}{2}\right)}{3!}\times\left(\frac{A}{m}\right)^3=\ldots$ with their numerical value of A.

Must be consistent with their $\ldots\left(1+\frac{A}{m}x\right)^{-\frac{1}{2}}$ from part (a) where m could be 1

Note the omission of the "3" with a correct A leads to coefficient of $-\frac{5}{3456}$.

A1: $-\frac{5}{1152}$. Condone $-\frac{5}{1152}x^3$ which may be seen embedded in an expansion.

Correct answer only with correct work in (a) scores both marks.

Expansions for reference

$$6(4+Ax)^{-\frac{1}{2}}=6\times4^{-\frac{1}{2}}\left(1+\frac{A}{4}x\right)^{-\frac{1}{2}}=3\left(1-\frac{A}{8}x+\frac{3A^2}{128}x^2-\frac{5A^3}{1024}x^3+\ldots\right)$$

$$=3-\frac{3A}{8}x+\frac{9A^2}{128}x^2-\frac{15A^3}{1024}x^3+\ldots$$

or e.g. (direct expansion)

$$6(4+Ax)^{-\frac{1}{2}}=6\left(4^{-\frac{1}{2}}+\left(-\frac{1}{2}\right)4^{-\frac{3}{2}}(Ax)+\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)}{2}4^{-\frac{5}{2}}(Ax)^2+\frac{\left(-\frac{1}{2}\right)\left(-\frac{1}{2}-1\right)\left(-\frac{1}{2}-2\right)}{3!}4^{-\frac{7}{2}}(Ax)^3+\ldots\right)$$

$$=6\left(\frac{1}{2}-\frac{1}{16}(Ax)+\frac{3}{256}(Ax)^2-\frac{5}{2048}(Ax)^3+\ldots\right)=3-\frac{3A}{8}x+\frac{9A^2}{128}x^2-\frac{15A^3}{1024}x^3+\ldots$$

Question Number	Scheme	Marks
4(i)	$\dfrac{\mathrm{d}V}{\mathrm{d}t} = 70\pi$	B1
	$\dfrac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$	B1
	$\dfrac{\mathrm{d}V}{\mathrm{d}t} = \dfrac{\mathrm{d}V}{\mathrm{d}r} \times \dfrac{\mathrm{d}r}{\mathrm{d}t} \Rightarrow 70\pi = 4\pi \times 5^2 \times \dfrac{\mathrm{d}r}{\mathrm{d}t}$ or e.g. $\dfrac{\mathrm{d}r}{\mathrm{d}t} = \dfrac{\mathrm{d}V}{\mathrm{d}t} \times \dfrac{\mathrm{d}r}{\mathrm{d}V} \Rightarrow \dfrac{\mathrm{d}r}{\mathrm{d}t} = 70\pi \times \dfrac{1}{4\pi \times 5^2}$	M1
	$\left(\dfrac{\mathrm{d}r}{\mathrm{d}t}\right) = 0.7$ (cm s^{-1}) oe e.g. $\dfrac{7}{10}$	A1
		(4)
	Alternative:	
	$V = 70\pi t$	B1
	$\dfrac{4}{3}\pi r^3 = 70\pi t$	B1
	$\dfrac{4}{3}\pi r^3 = 70\pi t \Rightarrow 4\pi r^2 \dfrac{\mathrm{d}r}{\mathrm{d}t} = 70\pi \Rightarrow 100\dfrac{\mathrm{d}r}{\mathrm{d}t} = 70$ or $\dfrac{4}{3}\pi r^3 = 70\pi t \Rightarrow r^3 = \dfrac{105}{2}t \Rightarrow r = \left(\dfrac{105}{2}t\right)^{\frac{1}{3}}$ $\left(\dfrac{4}{3}\pi r^3 = 70\pi t \Rightarrow \dfrac{500}{3}t = 70 \Rightarrow t = \dfrac{50}{21}\right)$ $\Rightarrow \dfrac{\mathrm{d}r}{\mathrm{d}t} = \dfrac{1}{3}\left(\dfrac{105}{2}\right)^{\frac{1}{3}} t^{-\frac{2}{3}} = \dfrac{1}{3}\left(\dfrac{105}{2}\right)^{\frac{1}{3}}\left(\dfrac{50}{21}\right)^{-\frac{2}{3}}$	M1
	$\left(\dfrac{\mathrm{d}r}{\mathrm{d}t}\right) = 0.7$ (cm s^{-1}) oe e.g. $\dfrac{7}{10}$	A1

Notes:

B1: States or uses $\dfrac{\mathrm{d}V}{\mathrm{d}t} = 70\pi$ oe e.g. $\dfrac{\mathrm{d}t}{\mathrm{d}V} = \dfrac{1}{70\pi}$

B1: States or uses $\dfrac{\mathrm{d}V}{\mathrm{d}r} = 4\pi r^2$ oe e.g. $\dfrac{\mathrm{d}r}{\mathrm{d}V} = \dfrac{1}{4\pi r^2}$ which may be seen as $\dfrac{\mathrm{d}V}{\mathrm{d}r} = 100\pi$ or $\dfrac{\mathrm{d}r}{\mathrm{d}V} = \dfrac{1}{100\pi}$ if $r = 5$ has been substituted.

M1: Attempts to use $\dfrac{\mathrm{d}V}{\mathrm{d}t} = \dfrac{\mathrm{d}V}{\mathrm{d}r} \times \dfrac{\mathrm{d}r}{\mathrm{d}t}$ or equivalent with $r = 5$ and their $\dfrac{\mathrm{d}V}{\mathrm{d}r}$ and $\dfrac{\mathrm{d}V}{\mathrm{d}t}$ correctly placed e.g. $70\pi = 4\pi \times 5^2 \times \dfrac{\mathrm{d}r}{\mathrm{d}t}$ or e.g. $\dfrac{\mathrm{d}r}{\mathrm{d}t} = \dfrac{\mathrm{d}V}{\mathrm{d}t} \times \dfrac{\mathrm{d}r}{\mathrm{d}V} = \dfrac{70\pi}{4\pi(5)^2}$

A1: $\left(\dfrac{\mathrm{d}r}{\mathrm{d}t}\right) = 0.7$ oe (Units are not required but if any are given they must be correct)