Question Number	Scheme	Marks
5.	One of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$	B1
	Two of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$	B1
Main	All three of $\frac{dA}{dt}=\frac{\pi}{20}$, $\frac{dA}{dx}=2\pi x$, $\frac{dV}{dx}=18\pi x^2$	B1
	Full attempt to find $\frac{dV}{dt}$ E.g. $\frac{dV}{dt}=\frac{dV}{dx}\times\frac{dx}{dA}\times\frac{dA}{dt}=18\pi x^2\times\frac{1}{2\pi x}\times\frac{\pi}{20}$	M1
	Finds $\frac{dV}{dt}$ at $x=2 \Rightarrow \frac{dV}{dt}=18\pi 2^2\times\frac{1}{80}=\frac{9}{10}\pi$	dM1 A1
		(6 marks)
	Note that the M1 may be found in two steps: E.g.I Finds $\frac{dx}{dt}$ from $\frac{dA}{dt}=\frac{dA}{dx}\times\frac{dx}{dt}$ followed by $\frac{dV}{dt}=\frac{dV}{dx}\times\frac{dx}{dt}$ E.g II Finds $\frac{dV}{dA}$ from $\frac{dV}{dx}=\frac{dV}{dA}\times\frac{dA}{dx}$ followed by $\frac{dV}{dt}=\frac{dV}{dA}\times\frac{dA}{dt}$	
Alt	$\frac{dA}{dt}=\frac{\pi}{20}$	B1
	$V=6\pi x^3, A=\pi x^2 \Rightarrow V=6\pi\left(\frac{A}{\pi}\right)^{\frac{3}{2}}$ $\frac{dV}{dA}=9\left(\frac{A}{\pi}\right)^{\frac{1}{2}}$	B1, B1
	$\frac{dV}{dt}=\frac{dV}{dA}\times\frac{dA}{dt}\Rightarrow\frac{dV}{dt}=9\left(\frac{A}{\pi}\right)^{\frac{1}{2}}\times\frac{\pi}{20}$	M1
	$x=2\Rightarrow A=4\pi$ $\Rightarrow \left.\frac{dV}{dt}\right\|_{A=4\pi}=\frac{9}{10}\pi$	dM1A1
		(6 marks)

Question Number	Scheme	Marks
10 (a)	Writes $2\left(4p^3+6p^2+3p\right)+1$ which is odd	B1
		(1)
(b)	Assumption:	
	E.g. States that there exists integers p and q such that $\sqrt[3]{2}=\frac{p}{q}$ (where $\frac{p}{q}$ is in its simplest form) and then cubes to get $2=\frac{p^3}{q^3}$	M1
	$2=\frac{p^3}{q^3}\Rightarrow p^3=2q^3$ and concludes that p^3 is even so therefore p is even	A1
	If p is even then it can be written $p=2m$ so $(2m)^3=2q^3$	M1
	States that $q^3=4m^3$ and concludes that q^3 is even so therefore q is even	A1
	This contradicts our initial statement, as if they both have a factor of 2 it means that $\frac{p}{q}$ is not in its simplest form, so $\sqrt[3]{2}$ is irrational *	A1*
		(5)
		(6 marks)

Question Number	Scheme	Marks
6(a)	$\frac{d\theta}{dt}=-k(\theta-15)^2\Rightarrow\int\frac{d\theta}{(\theta-15)^2}=\int -k\,dt$	B1
	$\int\frac{d\theta}{(\theta-15)^2}=-(\theta-15)^{-1}$	M1
	$-\frac{1}{\theta-15}=-kt+c$	A1
	$t=0,\theta=85\Rightarrow-\frac{1}{70}=c$	M1
	$t=10,\theta=40\Rightarrow\frac{1}{25}=10k+\frac{1}{70}\Rightarrow k=...\left(\frac{9}{3500}\right)$	M1
	$\frac{1}{\theta-15}=\frac{9t}{3500}+\frac{1}{70}\Rightarrow\theta=...$	M1
	$\theta=\frac{135t+4250}{9t+50}$	A1
		(7)
(b)	$20=\frac{135t+4250}{9t+50}\Rightarrow t=...$	M1
	$t=$ awrt 72	A1
		(2)
		Total 9

Question Number	Scheme	Marks
1 (a)	$(1+kx)^{\frac{1}{2}}=1+\left(\frac{1}{2}\right)\times(kx)+\frac{\left(\frac{1}{2}\right)\times\left(-\frac{1}{2}\right)}{2!}\times(kx)^2+\frac{\left(\frac{1}{2}\right)\times\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)}{3!}\times(kx)^3\ldots$	
(i)	$\frac{1}{2}k=\frac{1}{8}\Rightarrow k=\frac{1}{4}$	M1A1
(ii)	$A=\frac{\left(\frac{1}{2}\right)\times\left(-\frac{1}{2}\right)}{2!}\times"k"^2=-\frac{1}{128}$ $\quad B=\frac{\left(\frac{1}{2}\right)\times\left(-\frac{1}{2}\right)\times\left(-\frac{3}{2}\right)}{3!}\times"k"^3=\frac{1}{1024}$	M1 A1 A1
		(5)
(b)	Substitutes $x=0.6\Rightarrow\sqrt{1.15}=1+\frac{1}{8}\times0.6-"\frac{1}{128}"\times0.6^2+"\frac{1}{1024}"\times0.6^3=1.072398$	M1 A1
		(2)
		(7 marks)
1(b) alt	$(1+kx)^{\frac{1}{2}}=1+\left(\frac{1}{2}\right)\times(kx)-\left(\frac{1}{8}\right)\times(kx)^2+\left(\frac{1}{16}\right)\times(kx)^3$	
	Substitutes $"kx"=0.15$	
	$\Rightarrow\sqrt{1.15}=1+\frac{1}{2}\times0.15-\frac{1}{8}\times0.15^2+\frac{1}{16}\times0.15^3=1.072398$	M1A1
		(2)

Question Number	Scheme	Marks
4 (a)	$\frac{1}{\sqrt{1-2x}}=(1-2x)^{-\frac{1}{2}}=1+\left(-\frac{1}{2}\right)(-2x)+\frac{\left(-\frac{1}{2}\right)\left(-\frac{3}{2}\right)}{2!}(-2x)^2$	M1A1
	$\frac{2+3x}{\sqrt{1-2x}}=(2+3x)(1+x+\frac{3}{2}x^2+\ldots$	dM1
	$=2+5x+6x^2$ *	A1*
		(4)
(b)	Sub $x=\frac{1}{20}$ into both sides of $\frac{2+3x}{\sqrt{1-2x}}=2+5x+6x^2$	M1
	$\frac{\frac{43}{20}}{\sqrt{\frac{9}{10}}}=\frac{453}{200}\Rightarrow\sqrt{10}=..$	dM1
	$\sqrt{10}=\frac{1359}{430}$	A1
		(3)
		(7 marks)

Question Number	Scheme	Marks
1(a)	$(2-5x)^{-2}=\frac{1}{4}\left(1-\frac{5x}{2}\right)^{-2}$ or e.g. $\frac{8}{4\left(1-\frac{5x}{2}\right)^{2}}$	B1
	$=8\times\frac{1}{4}\left(1+(-2)\times\left(-\frac{5x}{2}\right)+\frac{(-2)\times(-3)}{2!}\times\left(-\frac{5x}{2}\right)^{2}+\frac{(-2)\times(-3)\times(-4)}{3!}\times\left(-\frac{5x}{2}\right)^{3}...\right)$	M1A1
	$\frac{8}{(2-5x)^{2}}=2+10x+\frac{75}{2}x^{2}+125x^{3}...$	A1
		(4)
Alt (a) by direct expansion	$8\times(2-5x)^{-2}$ $=8\times\left(2^{-2},+(-2)2^{-3}(-5x)^{1}+\frac{-2\times-3}{2!}2^{-4}(-5x)^{2}+\frac{-2\times-3\times-4}{3!}2^{-5}(-5x)^{3}\right)$	B1, M1A1
	$\frac{8}{(2-5x)^{2}}=2+10x+\frac{75}{2}x^{2}+125x^{3}...$	A1
(b)	$\lvert x\rvert<\frac{2}{5}$ o.e.	B1
		(1)
		(5 marks)

Question Number	Scheme	Marks
2	$\frac{dV}{dt}=\pm k$	B1
	$V=\frac{4}{3}\pi r^{3}\rightarrow\frac{dV}{dr}=4\pi r^{2}$	B1
	$\pm k=\lambda r^{2}\times\frac{dr}{dt}$	M1
	$\frac{dr}{dt}=\frac{\pm k}{4\pi r^{2}}\Rightarrow\frac{dr}{dt}\propto\frac{1}{r^{2}}$ ✓ *	A1*
		(4 marks)

Question Number	Scheme	Marks
5(i)	$\int x^{2}e^{x}\,dx=x^{2}e^{x}-\int 2xe^{x}\,dx(+c)$	M1A1
	$\int xe^{x}\,dx=xe^{x}-\int e^{x}\,dx(+c)$	M1
	$\int x^{2}e^{x}\,dx=x^{2}e^{x}-2xe^{x}+2e^{x}(+c)$ Also allow $\int x^{2}e^{x}\,dx=x^{2}e^{x}-\left(2xe^{x}-2e^{x}\right)(+c)$	A1
		(4)

(ii)	$u=(1-3x)^{\frac{1}{2}} \Rightarrow u^2=1-3x \Rightarrow 2u\dfrac{\mathrm{d}u}{\mathrm{d}x}=-3$ or $u=(1-3x)^{\frac{1}{2}} \Rightarrow \dfrac{\mathrm{d}u}{\mathrm{d}x}=-\dfrac{3}{2}(1-3x)^{-\frac{1}{2}}$	B1
	$\displaystyle\int \frac{27x}{\sqrt{1-3x}}\mathrm{d}x = 27\int \frac{\frac{1-u^2}{3}}{u}\left(-\frac{2u}{3}\right)\mathrm{d}u$ or $\displaystyle\int \frac{27x}{\sqrt{1-3x}}\mathrm{d}x = 27\int \frac{\frac{1-u^2}{3}}{\sqrt{1-3x}}\left(-\frac{2}{3}\sqrt{1-3x}\right)\mathrm{d}u$	M1
	$6\displaystyle\int (u^2-1)\mathrm{d}u$ or $-6\displaystyle\int (1-u^2)\mathrm{d}u$	A1
	$6\left(\dfrac{u^3}{3}-u\right)(+k)$	A1ft
	$6\left(\dfrac{(1-3x)^{\frac{3}{2}}}{3}-(1-3x)^{\frac{1}{2}}\right)(+k)=2(1-3x)^{\frac{1}{2}}(1-3x-3)(+k)$	M1
	$=-2(1-3x)^{\frac{1}{2}}(2+3x)(+k)$ or $=-2(1-3x)^{\frac{1}{2}}(3x+2)(+k)$	A1
		(6)
		Total 10

Question Number	Scheme	Marks
9(a)	$\tan\theta=\sqrt{3} \Rightarrow k=\dfrac{\pi}{3}$ (or $60°$) (Allow $x=\sqrt{3} \Rightarrow \theta=\dfrac{\pi}{3}$ (or $60°$))	B1
	$V=(\pi)\displaystyle\int y^2\mathrm{d}x=(\pi)\int (2\sin 2\theta)^2\sec^2\theta\,\mathrm{d}\theta$ oe	M1A1
	$4(\pi)\displaystyle\int \sin^2 2\theta\sec^2\theta\;\mathrm{d}\theta=4(\pi)\int 4\sin^2\theta\cancel{\cos^2\theta}\times\frac{1}{\cancel{\cos^2\theta}}\;\mathrm{d}\theta$	**d**M1
	$=16(\pi)\displaystyle\int \sin^2\theta\,\mathrm{d}\theta$ oe e.g. $16(\pi)\displaystyle\int (1-\cos^2\theta)\,\mathrm{d}\theta$	A1
	$\sin^2\theta=\dfrac{1-\cos 2\theta}{2} \Rightarrow 16(\pi)\displaystyle\int \sin^2\theta\;\mathrm{d}\theta=16(\pi)\int \frac{1-\cos 2\theta}{2}\;\mathrm{d}\theta$	**d**M1
	Volume $=\displaystyle\int_0^{\frac{\pi}{3}} 8\pi(1-\cos 2\theta)\,\mathrm{d}\theta$	A1 **Cso**
		(7)
(b)	$\displaystyle\int (1-\cos 2\theta)\mathrm{d}\theta \to \theta-\frac{\sin 2\theta}{2}$	B1
	Volume $=\displaystyle\int_0^{\frac{\pi}{3}} 8\pi(1-\cos 2\theta)\,\mathrm{d}\theta=\left[8\pi\theta-4\pi\sin 2\theta\right]_0^{\frac{\pi}{3}}=\frac{8}{3}\pi^2-2\sqrt{3}\pi$	M1 A1
		(3)
		(10 marks)

Question Number	Scheme	Marks
7. (a)	Attempts $\overrightarrow{BA}\cdot\overrightarrow{BC}$ $\begin{pmatrix}-6\\2\\-3\end{pmatrix}\bullet\begin{pmatrix}-4\\3\\-5\end{pmatrix}=24+6+15=45$	M1
	Attempts to apply $\mathbf{a}\bullet\mathbf{b}=\lvert\mathbf{a}\rvert\lvert\mathbf{b}\rvert\cos\theta\Rightarrow 45=7\times\sqrt{50}\cos\theta$	dM1
	$\cos\theta=\dfrac{9\sqrt{2}}{14}$ oe	A1
		(3)
(b)	Attempts $\sin\theta=\sqrt{1-\left(\dfrac{9\sqrt{2}}{14}\right)^2}$	M1
	Attempts to apply $\lvert\mathbf{a}\rvert\lvert\mathbf{b}\rvert\sin\theta=7\times\sqrt{50}\times\dfrac{\sqrt{34}}{14}$	M1
	Area *ABCD* = $5\sqrt{17}$	A1
		(3)
		(6 marks)

Question Number	Scheme	Marks
6	$u=\sqrt{x^3+1}\Rightarrow u^2=x^3+1\Rightarrow 2u\dfrac{du}{dx}=3x^2$ or $u=\sqrt{x^3+1}\Rightarrow u^2=x^3+1\Rightarrow 2u=3x^2\dfrac{dx}{du}$ or $u=\sqrt{x^3+1}\Rightarrow\dfrac{du}{dx}=\dfrac{1}{2}\left(x^3+1\right)^{-\frac{1}{2}}\times 3x^2$ or $x=(u^2-1)^{\frac{1}{3}}\Rightarrow\dfrac{dx}{du}=\dfrac{2}{3}u(u^2-1)^{-\frac{2}{3}}$	B1
	e.g. $\displaystyle\int\frac{9x^5}{\sqrt{x^3+1}}dx=\int\frac{9x^5}{u}\frac{2u}{3x^2}du=\int 6x^3\,du=6\int\left(u^2-1\right)du$ or e.g. $\displaystyle\int\frac{9x^5}{\sqrt{x^3+1}}dx=\int\frac{9x^5}{\sqrt{x^3+1}}\frac{2\sqrt{x^3+1}}{3x^2}du=\int 6x^3\,du=6\int\left(u^2-1\right)du$	M1A1
	$\displaystyle 6\int\left(u^2-1\right)du=2u^3-6u\ (+c)=2\left(x^3+1\right)^{\frac{3}{2}}-6\left(x^3+1\right)^{\frac{1}{2}}\ (+c)$	M1
	$=2\left(x^3+1\right)^{\frac{1}{2}}\left[\left(x^3+1\right)-3\right]+c=2\left(x^3+1\right)^{\frac{1}{2}}\left(x^3-2\right)+c$	A1
		(5)
		Total 5